A MODIFIED DYNAMIC HIP SCREW IN UNSTABLE INTERTROCHANTERIC FRACTURE: A RETRO-PROSPECTIVE STUDY

Dissertation submitted to

The Tamil Nadu Dr. M.G.R Medical University, Chennai

In fulfilment of the requirements for the award of the degree of

MASTER OF SURGERY IN ORTHOPAEDICS

Under the guidance of

Dr.B.K.Dinakar Rai D.Ortho., M.S.(Ortho)

Professor & HOD

DEPARTMENT OF ORTHOPAEDICS

PSG INSTITUTE OF MEDICAL SCIENCES & RESEARCH, COIMBATORE

THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY, CHENNAI, TAMILNADU

2018

CERTIFICATE BY THE HOD AND DEAN OF THE INSTITUTION

This is to certify that the dissertation entitled, **"A MODIFIED DYNAMIC HIP SCREW HIP IN UNSTABLE INTERTROCHANTERIC FRACTURE:A RETRO-PROSPECTIVE STUDY"** is the bonafide original research work of **Dr PRAVEEN.D** under the guidance of **Dr.B.K.Dinakar Rai., D.Ortho., M.S.(Ortho),** Professor & HOD, department of Orthopaedics, PSG IMS&R, Coimbatore in partial fulfilment of the requirements for the degree of Master of Surgery in Orthopaedics.

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Dean

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This is to certify that the dissertation entitled, "**A MODIFIED DYNAMIC HIP SCREW IN UNSTABLE INTERTROCHANTERIC FRACTURE: A RETRO-PROSPECTIVE STUDY"** is the bonafide original work of **Dr.PRAVEEN.D,** done under my direct guidance and supervision in the Department of Orthopaedics, PSG Institute of Medical Sciences and Research, Coimbatore in fulfilment of the regulations by The Tamil Nadu Dr.MGR Medical University, Chennai for the degree of Master of Surgery in Orthopaedics.

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **"A MODIFIED DYNAMIC HIP SCREW IN UNSTABLE INTROCHANTERIC FRACTURE: A RETRO-PROSPECTIVE STUDY"** is a bonafide and genuine research work carried out by me under the guidance of **Dr . B.K.Dinakar Rai.,D.ORTHO.,M.S.(ORTHO) ,**Professor & HOD, Department of Orthopeadics, PSG IMS&R, Coimbatore. This dissertation is submitted to The Tamil Nadu Dr.M.G.R Medical University in fulfilment of the university regulations for the award of degree of Master of Surgery in Orthopaedics. This dissertation has not been submitted for award of any other degree or diploma.

Signature of the Candidate

Dr.PRAVEEN.D

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This is to certify that this dissertation work titled **A MODIFIED DYNAMIC HIP SCREW IN UNSTABLE INTERTROCHANTERIC FRACTURE: A RETRO-PROSPECTIVE STUDY** of the candidate **PRAVEEN.D** with registration Number **221512451** for the award of **MASTER OF SURGERY** in the branch of **ORTHOPAEDICS**. I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **13%** of plagiarism in the dissertation.

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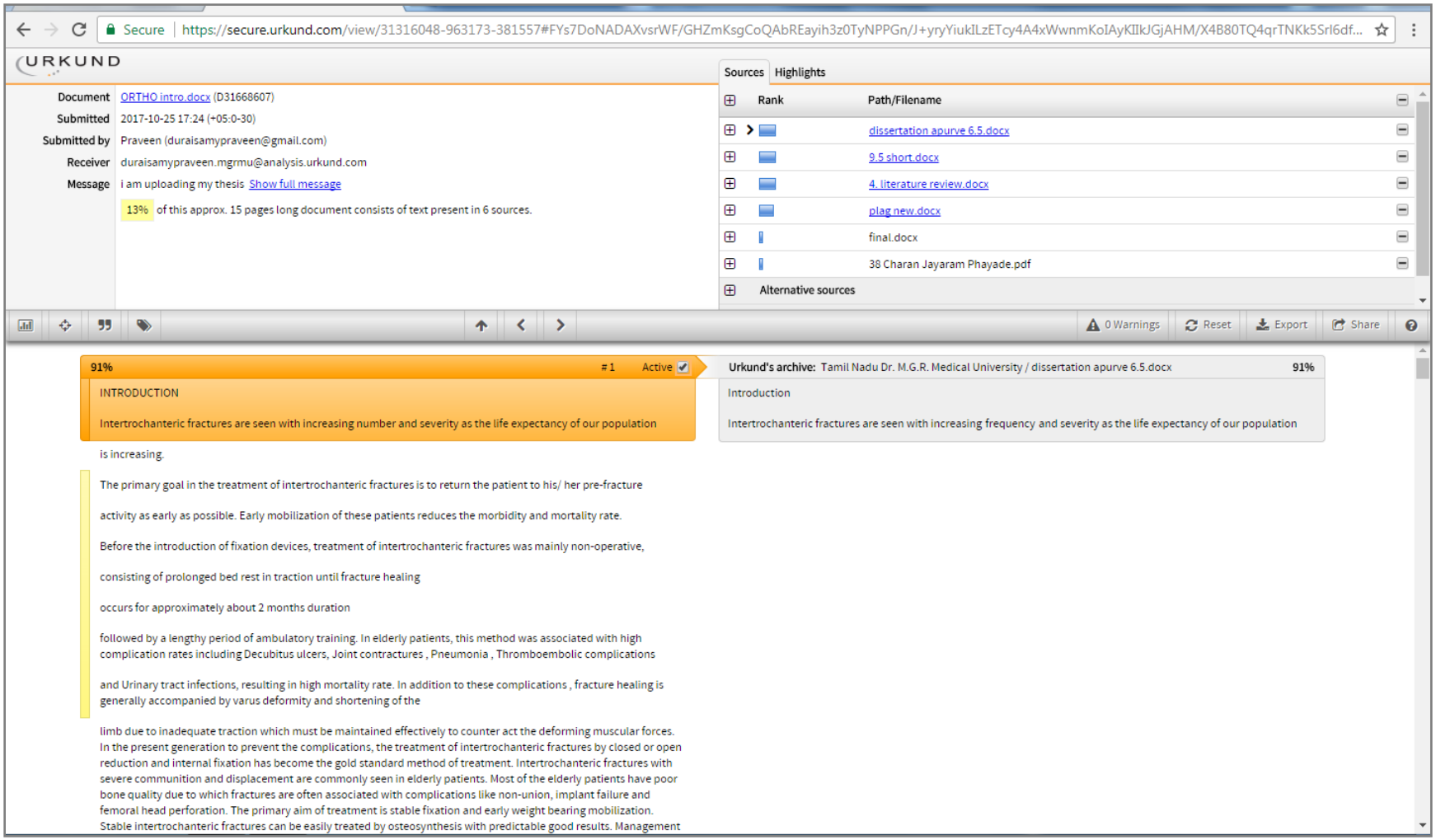
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INTRODUCTION
Intertrochanteric fractures are seen with increasing number and severity as the life expectancy of our population
is increasing.
The primary goal in the treatment of intertrochanteric fractures is to return the patient to his/ her pre-fracture
activity as early as possible. Early mobilization of these patients reduces the morbidity and mortality rate.
Before the introduction of fixation devices, treatment of intertrochanteric fractures was mainly non-operative,
consisting of prolonged bed rest in traction until fracture healing
occurs for approximately about 2 months duration
followed by a lengthy period of ambulatory training. In elderly patients, this method was associated with high complication rates including Decubitus ulcers, Joint contractures , Pneumonia , Thromboembolic complications
and Urinary tract infections, resulting in high mortality rate. In addition to these complications , fracture healing is generally accompanied by varus deformity and shortening of the
limb due to inadequate traction which must be maintained effectively to counter act the deforming muscular forces. In the present generation to prevent the complications, the treatment of intertrochanteric fractures by closed or open reduction and internal fixation has become the gold standard method of treatment. Intertrochanteric fractures with severe communition and displacement are commonly seen in elderly patients. Most of the elderly patients have poor bone quality due to which fractures are often associated with complications like non-union, implant failure and femoral head perforation. The primary aim of treatment is stable fixation and early weight bearing mobilization. Stable intertrochanteric fractures can be easily treated by osteosynthesis with predictable good results. Management
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Introduction
Intertrochanteric fractures are seen with increasing frequency and severity as the life expectancy of our population

ACKNOWLEDGEMENT

At the outset, I thank the god for giving me the strength to perform all my duties.

It is indeed a great pleasure to recall the people who have helped me in the completion of dissertation. Naming all the people who have helped me achieving this goal would be impossible , yet I attempt to thank a selected few who have helped me in diverse ways.

I acknowledge and express my humble gratitude and sincere thanks to my beloved teacher and guide **Dr. B. K. Dinakar Rai ., D.Ortho., M.S. (Ortho)**, Professor & HOD, department of orthopaedics, PSG IMS&R, Coimbatore for his valuable suggestion, guidance, great care and attention to details, that he has so willingly shown in the preparation of this dissertation.

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I owe a great deal of respect and gratitude to my professor, **Dr. N.Venkatesh Kumar D.Ortho, DNB**., for his whole hearted support in completion of this dissertation.

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I also express my sincere thanks to my Assistant professors **Dr. Yeseswi Tellakula** and **Dr. Sajjad Ali** Department of Orthopaedics, PSG IMS&R, Coimbatore for their timely suggestions and all round encouragement.

I am immensely indebted to my parents for their continuous support without them this study could not have been reality.

My sincere thanks to the OP staff, Post graduate colleagues and my friends for their whole hearted support.

Finally I thank my patients who formed the backbone of this study without whom this study would have not been possible.

CONTENTS

INTRODUCTION

Intertrochanteric fractures are seen with increasing number and severity as the life expectancy of our population is increasing. The primary goal in the treatment of intertrochanteric fractures is to return the patient to his/ her pre-fracture activity as early as possible. Early mobilization of these patients reduces the morbidity and mortality rate.

Before the introduction of fixation devices, treatment of intertrochanteric fractures was mainly non-operative, consisting of prolonged bed rest in traction until fracture healing occurs for approximately about 2 months duration followed by a lengthy period of ambulatory training. In elderly patients, this method was associated with high complication rates including Decubitus ulcers, Joint contractures , Pneumonia , Thromboembolic complications and Urinary tract infections, resulting in high mortality rate. In addition to these complications , fracture healing is generally accompanied by varus deformity and shortening of the limb due to inadequate traction which must be maintained effectively to counter act the deforming muscular forces.

In the present generation to prevent the complications, the treatment of intertrochanteric fractures by closed or open reduction and internal fixation has become the gold standard method of treatment.

Intertrochanteric fractures with severe communition and displacement are commonly seen in elderly patients. Most of the elderly patients have poor bone quality due to which fractures are often associated with complications like non-union, implant failure and femoral head perforation.

The primary aim of treatment is stable fixation and early weight bearing mobilization. Stable intertrochanteric fractures can be easily treated by osteosynthesis with predictable good results. Management of unstable intertrochanteric fractures is challenging because of excessive collapse, loss of fixation, implant failure, lag screw cut out and in addition osteoporosis also adds to the complication resulting in unpredictable outcome.

Many treatment modalities have come up in management of these unstable intertrochanteric fractures. Each of them having their own share of complications. Sliding Hip Screw Fixation is still the gold standard in treatment of stable intertrochanteric fracture. In unstable comminuted intertrochanteric fractures, there is high incidence of failure in view of excessive collapse seen with normal Dynamic hip screw.

In order to limit the collapse we have done a modification on Dynamic Hip Screw implant. In this study we are assessing the outcome of unstable intertrochanteric fractures treated with modified dynamic hip screw fixation designed by us.

AIMS AND OBJECTIVES

Aim of the study:

The aim of this study is to assess fracture healing, collapse and implant failure, in unstable intertrochanteric fractures (Boyd and Griffin type-2) treated by modified DHS fixation.

Objectives:

1. To assess fracture healing in management of communited intertrochanteric fracture with modified Dynamic Hip Screw.
2. To assess collapse rate in management of communited intertrochanteric fracture with modified Dynamic Hip Screw.
3. To look for implant failure- migration of implant, implant loosening , implant cut-out or non-union.

REVIEW OF LITERATURE

Intertrochanteric fracture accounts for nearly fifty percent of fractures of the hip. They continue to be a major cause for disability resulting in reduced quality of life and also leading to death[2].

S.S.Babhulkar in 2006 stated that 90 percent of intertrochanteric fractures of the femur in elderly occurs majorly due to an osteoporotic bone after a simple fall ,where as in young individuals it may be due to a high velocity injuries such as motor vehicle accidents or fall from height[1].

Stable fixation with early mobilization is the treatment goal in intertrochanteric fractures of femur. Restoration of mobility in intertrochanteric fracture ultimately depends on surgical construct.

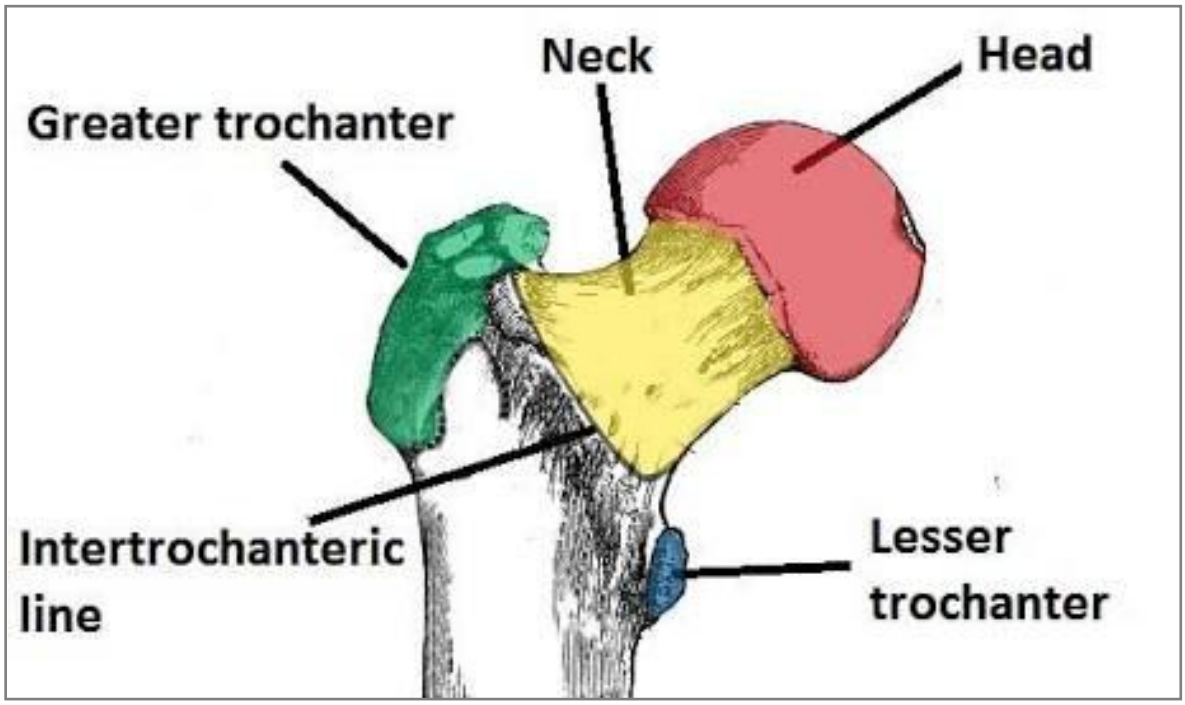
Arunsingh et al in 2006 have proposed that although rigid fixation can be achieved through various fixation , the Dyamic hip screw is the most commonly preferred device for intertrochanteric fracture [3].

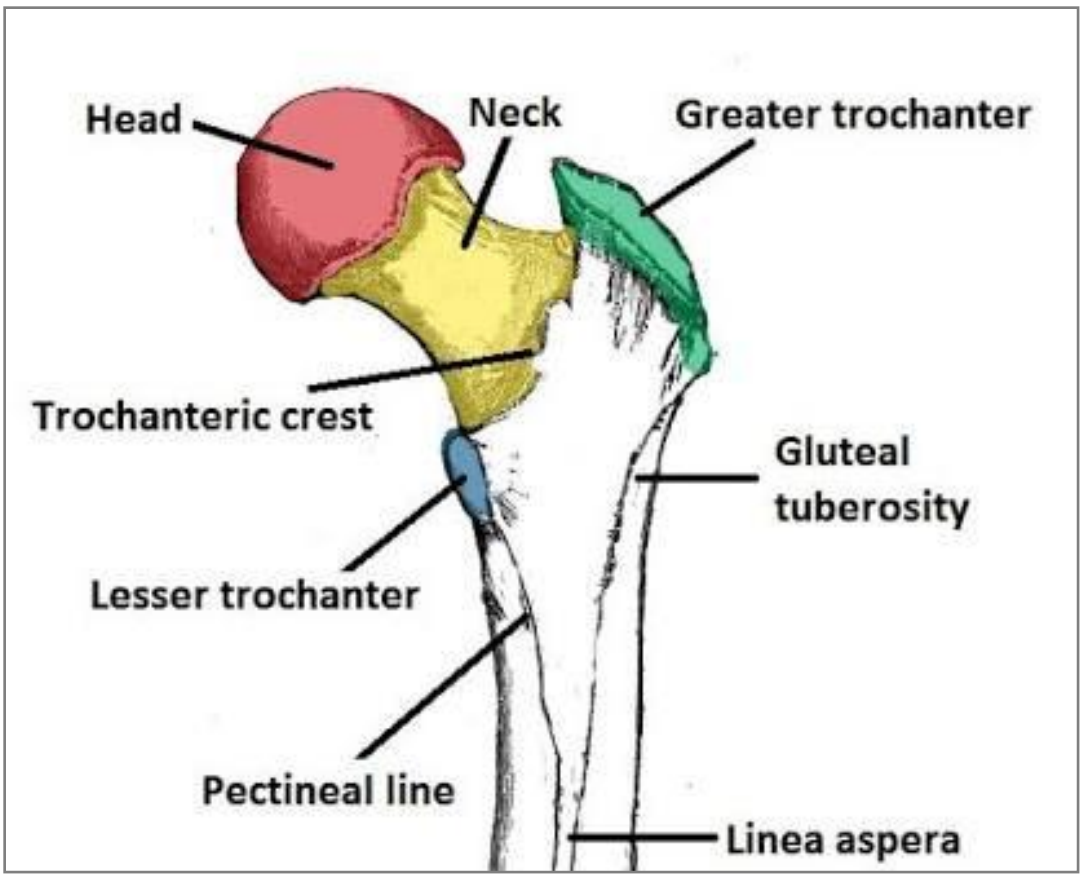
ANATOMY

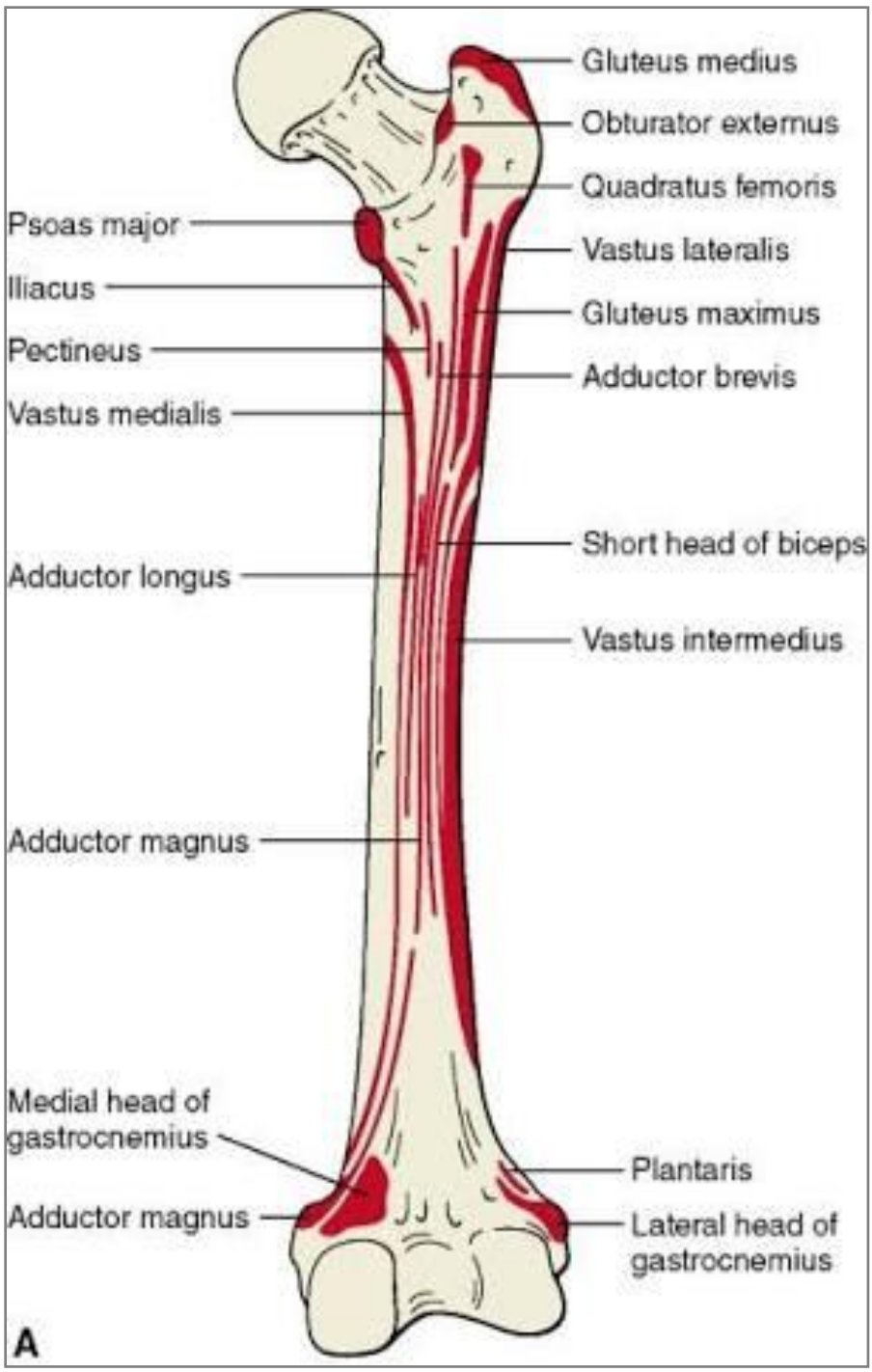
Proximal femur consists of head of femur, neck of femur , greater trochanter , lesser trochanter , intertrochanteric line and intertrochanteric crest.

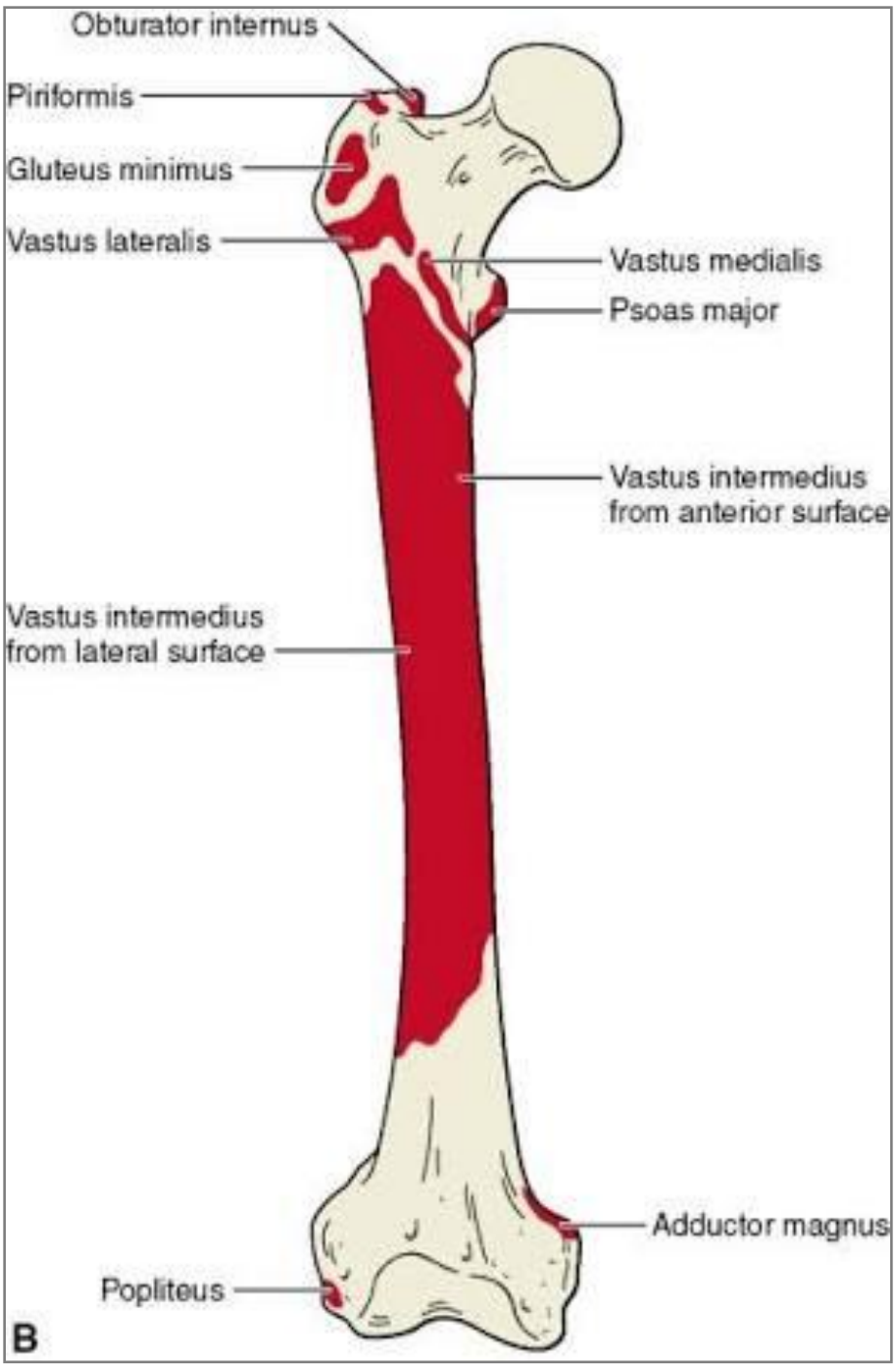
The femur is the second long bone in the body to start ossifying.

- The primaryossification centre appears in the shaft during seventh week of intrauterine life.
- Four secondary ossification centers are present
    - Firstly the lower end which appears at the end of ninth month of intrauterine life,
    - Secondly the head appears during first six months of life and fuses at around 16 years,
    - Thirdly greater trochanter appears during fourth year and fuses at 14 years and
    - Lastly lesser trochanter appears during 12 years and fuses by around 13 years.




Head
Neck
Greater trochanter
Trochanteric crest
Gluteal tuberosity
Lesser trochanter
Pectineal line
Linea aspera


Gluteus medius
Obturator externus
Quadratus femoris
Psoas major
Vastus lateralis
Iliacus
Gluteus maximus
Pectineus
Adductor brevis
Vastus medialis
Short head of biceps
Adductor longus
Vastus intermedius
Adductor magnus
Medial head of gastrocnemius
Plantaris
Adductor magnus
Lateral head of gastrocnemius
A


Obturator internus
Piriformis
Gluteus minimus
Vastus lateralis
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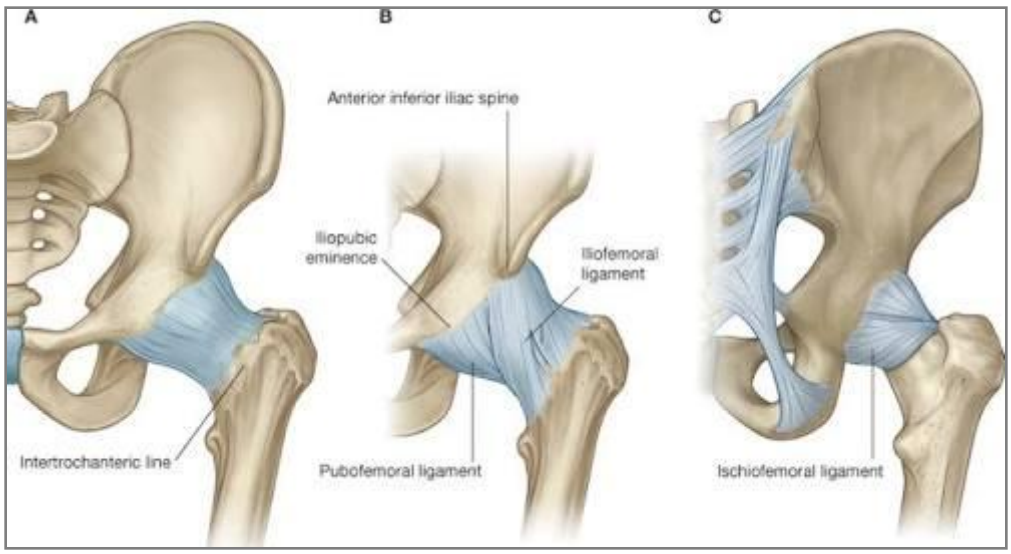
from lateral surface
Adductor magnus
Popliteus
B



HEAD OF THE FEMUR:

The head of the femur also called caput femoris which is globular in shape and forms more than a hemisphere and it is pointed upwards , rotated medially and directed slightly forward. The surface of the head is smooth , covered with cartilage and articulates with acetabulam to form the hip joint.The head consists of a roughened pit, located just below and behind its centre which is called the fovea capitis femoris. It provides attachments to the ligament of head of femur.

NECK OF FEMUR:

The neck also called collum femoris which is a flattened pyramidal process of bone connecting the head of femur with the shaft forming a wide angle opening in the medial side. The angle is maximum during infancy and reduces with growth. In an adult neck forms an angle of 120 to 135 degree with the shaft and maintains an anteversion of

5 to 15 degree it is also known as the Neck-Shaft angle. The neck shaft angle is reduced in females because of their wider pelvis.

The anterior surface of neck is perforated by numerous vascular channels. Posterior surface is smooth, broader and more concave than the anterior surface. The posterior capsule of the hip joint is attached over the posterior surface nearly 1cm above the intertrochanteric crest. Superior border of neck is short, thick and ends laterally at greater trochanter. The inferior border is long, narrow and ends at lesser trochanter.

The neck of femur is strengthened by calcarfemorale along its concave surface.

GREATER TROCHANTER:

The greater trochanter is large ,irregular quadrilateral eminence with four borders and two surfaces. The lateral surface, which is quadrilateral in form, is rough, convex, broad and is marked by diagonal impression which serves as a site of attachment for tendon of gluteus medius. The medial surface is of much less extent and presents as a deep impression called trochanteric fossa or digital fossa. This serves as an insertion site for tendon of obturator externus,obturator internus and gemelli.

Superior border is free, thick and irregular, serves for insertion of piriformis muscle. The inferior border corresponds to line of junction of base of trochanter with body and gives origin to upper part of vastus lateralis. Anterior border is prominent, irregular and affords insertion to gluteus minimus. The posterior border is prominent, appears as a free, rounded edge and bounds the back of trochanteric fossa.

LESSER TROCHANTER

It is a conical eminence directed backwards and medially from junction of neck and shaft of femur. Psoas major is inserted over the apex and medial part of rough anterior surface.

Iliacus muscle is inserted on anterior surface of base of lesser trochanter and the area below it.The smooth posterior surface is covered by a bursa due to upper horizontal fibres of adductor magnus.

INTERTROCHANTERIC LINE:

This line marks the junction of anterior surface of the neck with shaft of femur. It begins above at the anterosuperior angle of the greater trochanter and is continuous below with spiral line in front of lesser trochanter.

It provides attachment to:

1. Capsular ligament of the hip joint.
2. Upper band of ilio-femoral ligament in upper part.
3. Lower band of ilio-femoral ligament in lower part.
4. Origin to the highest fibres of vastus lateralis from its upper end and
5. Origin to the highest fibres of vastus medialis from its lower end.

INTERTROCHANTERIC CREST:

This marks the junction of posterior part of neck with shaft of femur. It begins above at posterosuperior angle of greater trochanter and ends at lesser trochanter. The rounded elevation called quadrate tubercle, provides insertion to quadrates femoris muscle.

BLOOD SUPPLY:

An extracapsular arterial ring is formed anteriorly by ascending branch of lateral femoral circumflex artery and posteriorly by medial circumflex femoral artery. The ascending cervical branch from this ring pierce the hip capsule near its distal insertion, becoming the retinacular vessels(anterior, posterior, medial and lateral) of which lateral retinacular group supply the major blood supply to femoral head. A sub-synovial intra-capsular arterial ring enter the femoral head and are at risk due to displacement that occurs following any fracture affecting the blood supply to the femoral head resulting in AVN if head is retained.

The artery of ligamentum teres, a branch of obturator artery supply a small portion of femoral head around the fovea capitis.

SENSORY SUPPLY:

The hip joint receives innervations from obturator, femoral, sciatic and superior gluteal nerves.

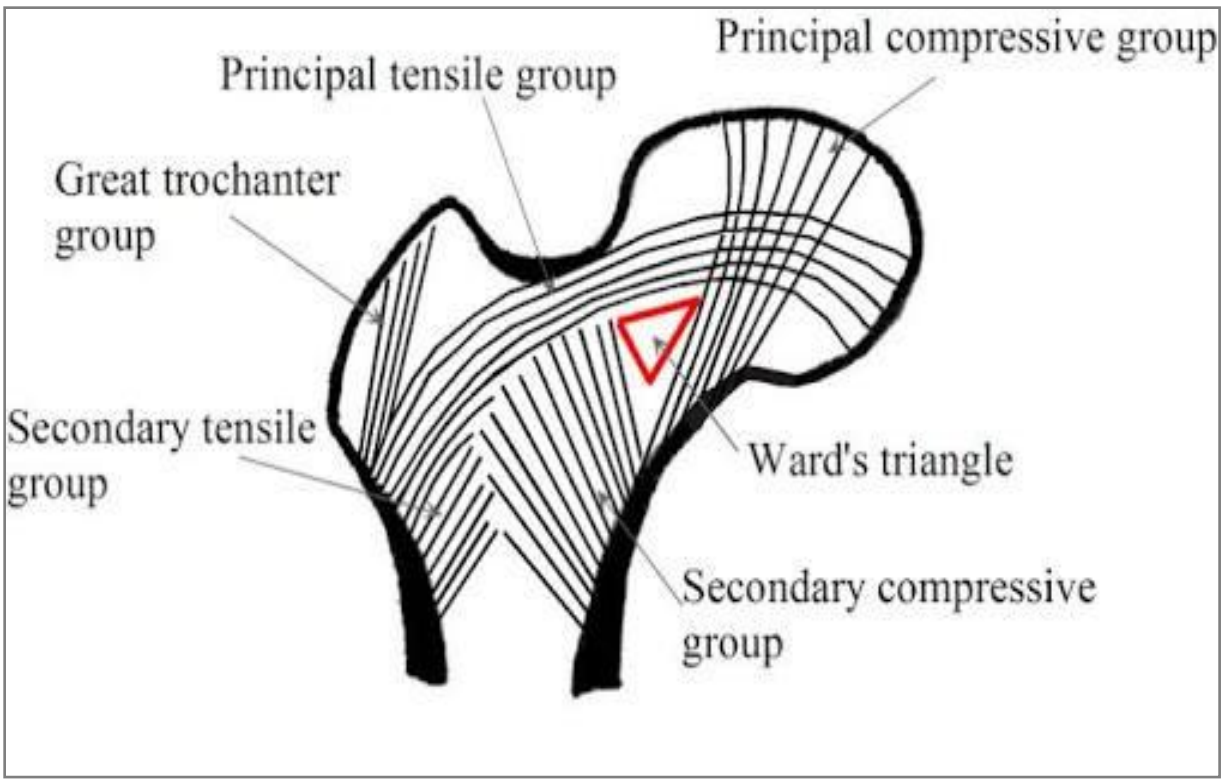
- Obturator innervates at anteromedial part of joint.

- Anterior capsule gets sensory innervations from femoral nerve.
- The posterior aspect of joint is innervated by sciatic nerve and posterolateral capsule gets its supply from superior gluteal nerve.

TRABECULAR PATTERN:

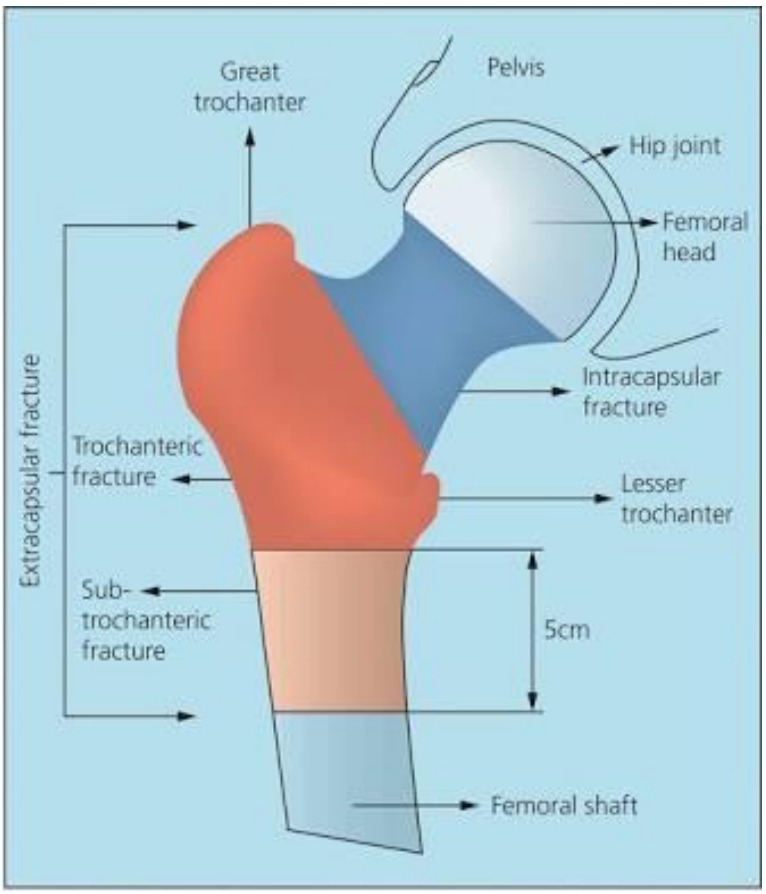
The trabecular architecture of proximal end of femur comprises of 5 distinct groups:

1. Primary compression trabeculae –They run from the weight bearing portion of the femoral head to the region of the calcarfemoris and the medial cortex.
2. Primary tension trabeculae –They begin in the inferior portion of the head and arch across the superior portion , terminating in the lateral cortex.
3. Trochanteric trabeculae –They begin in the greater trochanter and end in lateral cortex.
4. Secondary compression trabeculae-They extends from calcar and lesser trochanter to the greater trochanter.
5. Secondary tension trabeculae –These are found between primary trabeculae and acts as tie beams.The primary tensile and compression trabeculae,resists tensile and compression stress respectively.Trabecular bone is concentrated as thin layer deep to the subchondral bone.



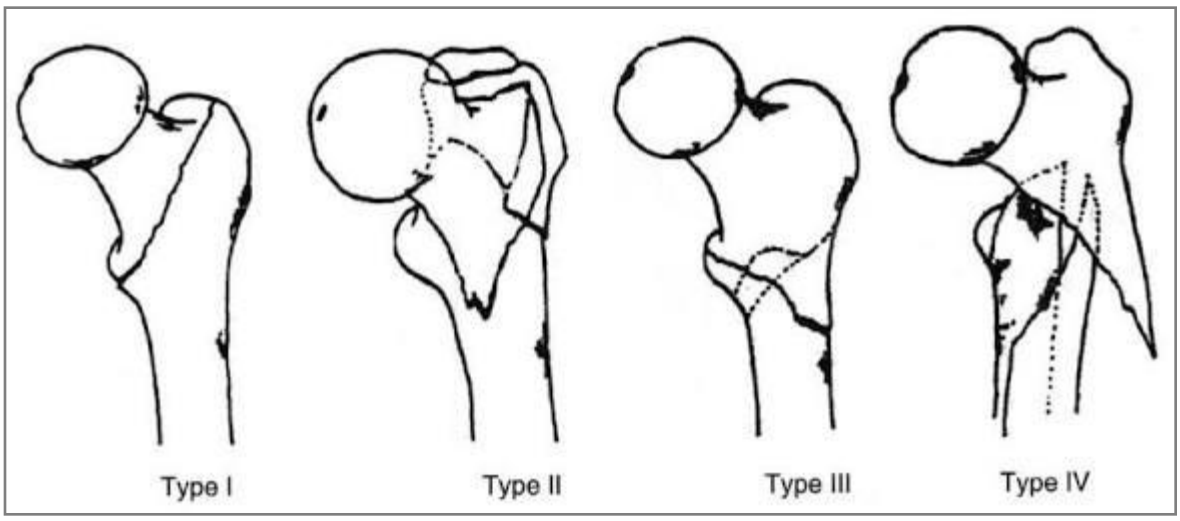
CLASSIFICATION

There is no single classification system till date that has achieved reliable reproducible validity. **Astley cooper** in 1822 proposed a classification system for hip fractures. He has divided into two major groups as intracapsular and extracapsular.



Commonly fractures are described by number of fragments and instability. Presence of certain characteristics like loss of posteromedial buttress, inadequate lateral wall indicates instability.

Boyd and Griffin (1949) classified fractures in the trochanteric area of femur into 4 types. Their classification included all fractures from extra capsular part of neck to a point 5cm below the lesser trochanter. Their classification is useful in planning treatment and estimating prognosis[32].



Type 1:

Fractures that extend along the intertrochanteric line from the greater to the lesser trochanter. Reduction usually is simple and is maintained with little difficulty. Results generally are satisfactory.

Type 2:

Comminuted fractures, the main fracture being along the line, but with multiple fractures in the cortex. Reduction of these fractures is more difficult because the comminution can vary from slight to extreme. A particularly deceptive form is the fracture in which an anteroposterior linear fracture occurs, as in type 1, but with an additional fracture in the coronal plane, which can be seen on the lateral radiograph.

Type 3:

Fractures that are basically subtrochanteric with at least one fracture passing across the proximal end of the shaft just distal to or at the lesser trochanter. Varying degrees of comminution are associated. These fractures usually are more difficult to reduce and result in more complications during surgery and convalescence period.

Type 4:

Fractures of the trochanteric region and the proximal shaft, with fracture in at least two planes, one of which usually is the sagittal plane and may be difficult to see on routine anteroposterior radiographs. If open reduction and internal fixation are used, two-plane fixation is required because of the spiral, oblique, or butterfly fracture of the shaft.

EVANS CLASSIFICATION:

Evans.E in 1949 presented a way simpler classification based on dividing the fractures into stable and unstable groups. He further divided the unstable into those in which stability could be restored by anatomic or near anatomic reduction and in those in which anatomic reduction would not produce stability[33].

Type 1:

The fracture line extends upwards and outwards from the lesser trochanter and there are 4 sub divisions.

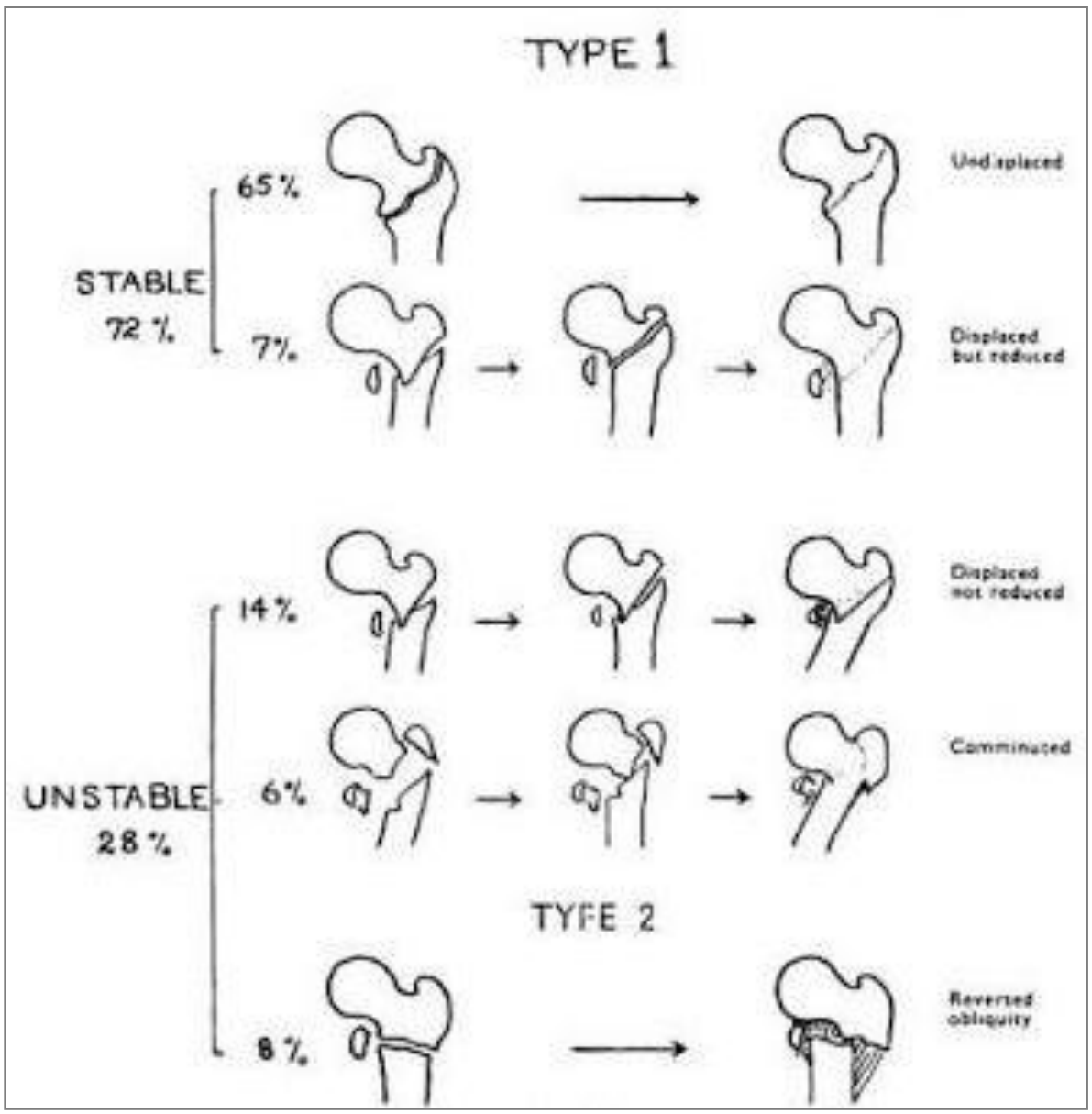
In the first group, comprising 65% of all cases, the inner cortical buttress has never been disturbed. There is no displacement and fractures unite in perfect position.

In the second group, simple overlap of the inner cortical buttress can be reduced by manipulation and the fracture thus becomes stable.

In third and fourth group, there is unreduced overlap or destruction of this cortical buttress and coxavera deformity is to be expected.

Type 2:

The obliquity of major farcture line is reversed, that is, it extends downward and outward from lesser trochanter. There is marked tendency to inward displacement of the femoral shaft but this does not affect the ultimate function.


TYPE 1
65%
Undisplaced
STABLE
72 %
7%
Displaced
but reduced
14%
Displaced
not reduced
UNSTABLE
28 %
6%
Comminuted
TYPE 2
8%
Reverted
obliquity

KYLE CLASSIFICATION[34]

TYPE-1 (STABLE):

Two part fracture that is undisplaced

TYPE-2 (STABLE):

Fractures that are displaced into Varus with a smaller lesser trochanteric fragment, but with an essentially intact posteromedial cortex.

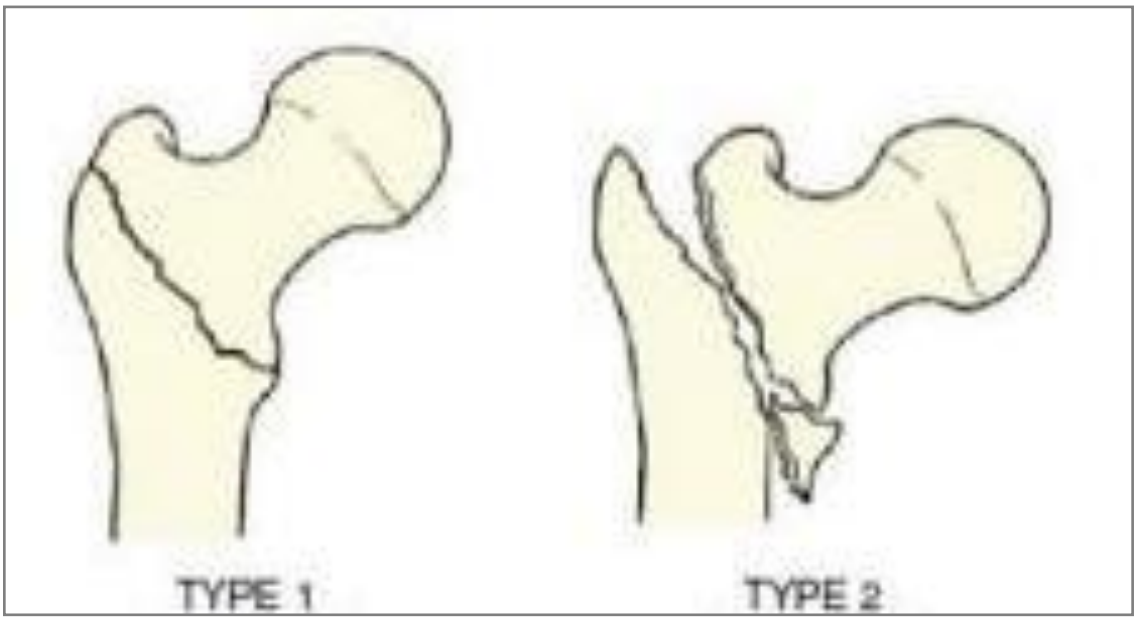
TYPE-3 (UNSTABLE):

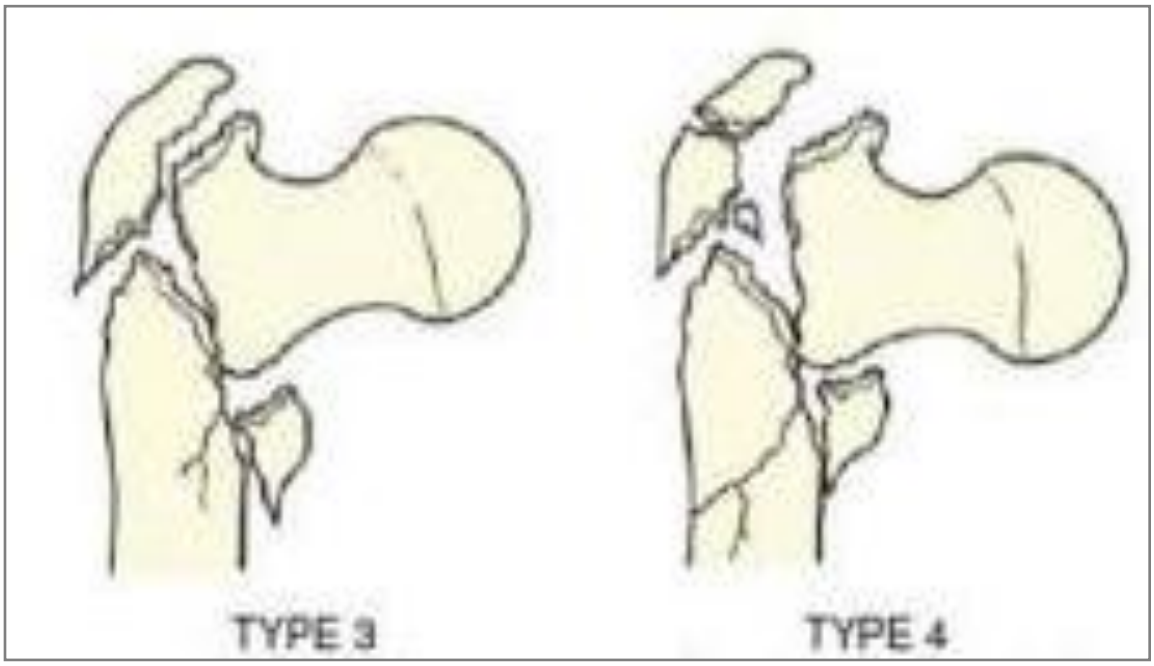
Four part fractures that are displaced into varus with posteromedial cortical communication and a greater trochanteric fragment.

TYPE-4 (UNSTABLE):

Type 3 fracture with subtrochanteric extension.

KYLE CLASSIFICATION:





TRONZO CLASSIFICATION:

Tronzoin in 1974 proposed the classification based on the reduction potential. According to him, trochanteric fractures are divided into 5 types and each type requires a specific mode of reduction and fixation with a nail plate assembly[46].

Type-1:

Incomplete trochanteric fractures

Type-2:

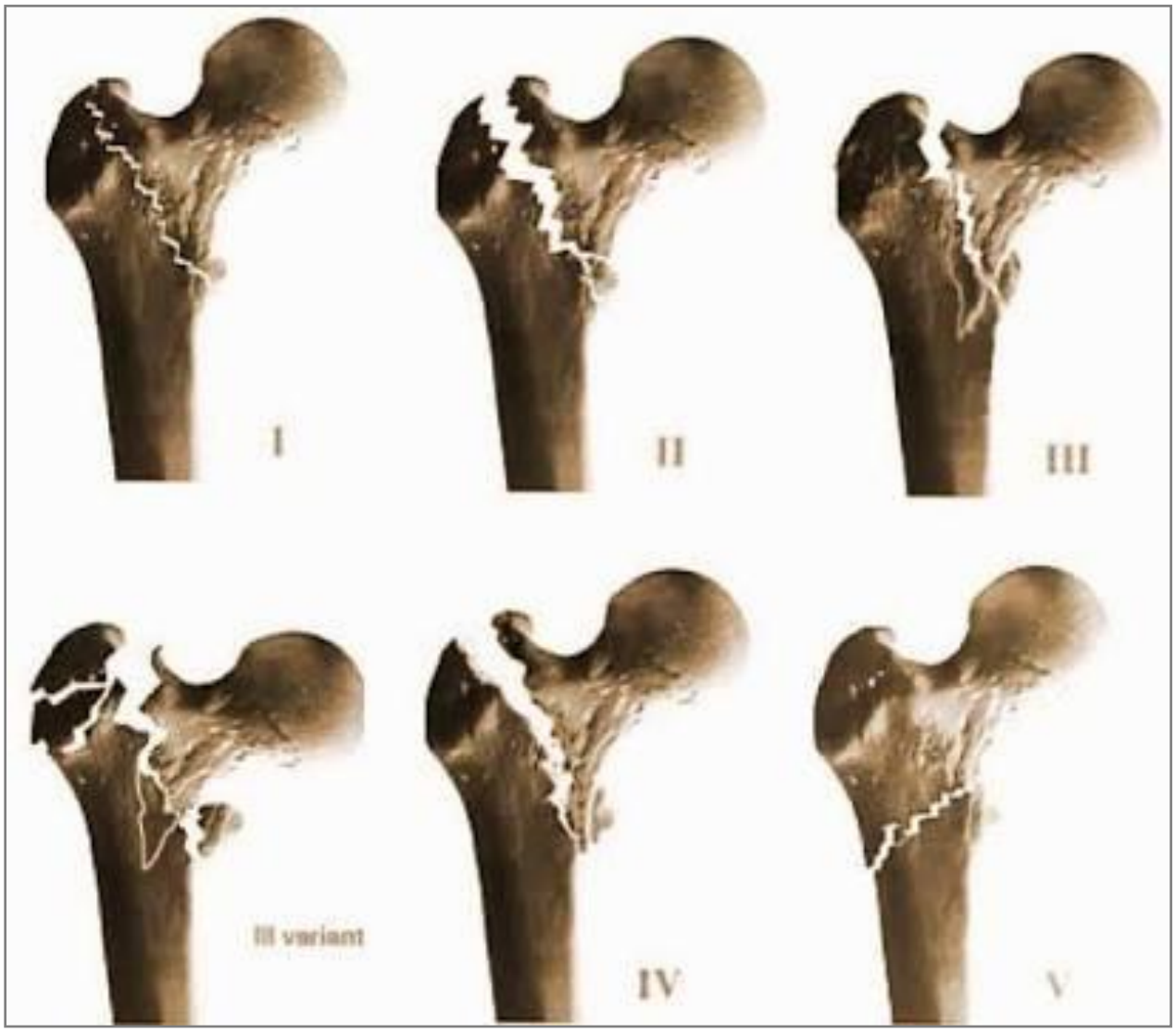
Non- comminuted trochanteric fracturers with or without displacement in which both trochanters are fractured.

Type-3:

Comminuted fractures in which the lesser trochanteric fragment is large. The posterior wall is exploded with the back of the inferior neck already displaced in the medullary cavity of the shaft fragment. These are unstable farctures. A variant of type 3 fracture also has the greater trochanter fractured off and separated.

Type-4:

Comminuted trochanteric fracture with disengagement of the two main fragments. Again these are unstable with posterior wall exploded, but the spike of the neck fragment is displaced outside of or medial to the shaft.



Type-5:

Trochanteric fractures with reverse obliquity.These are uncommon.

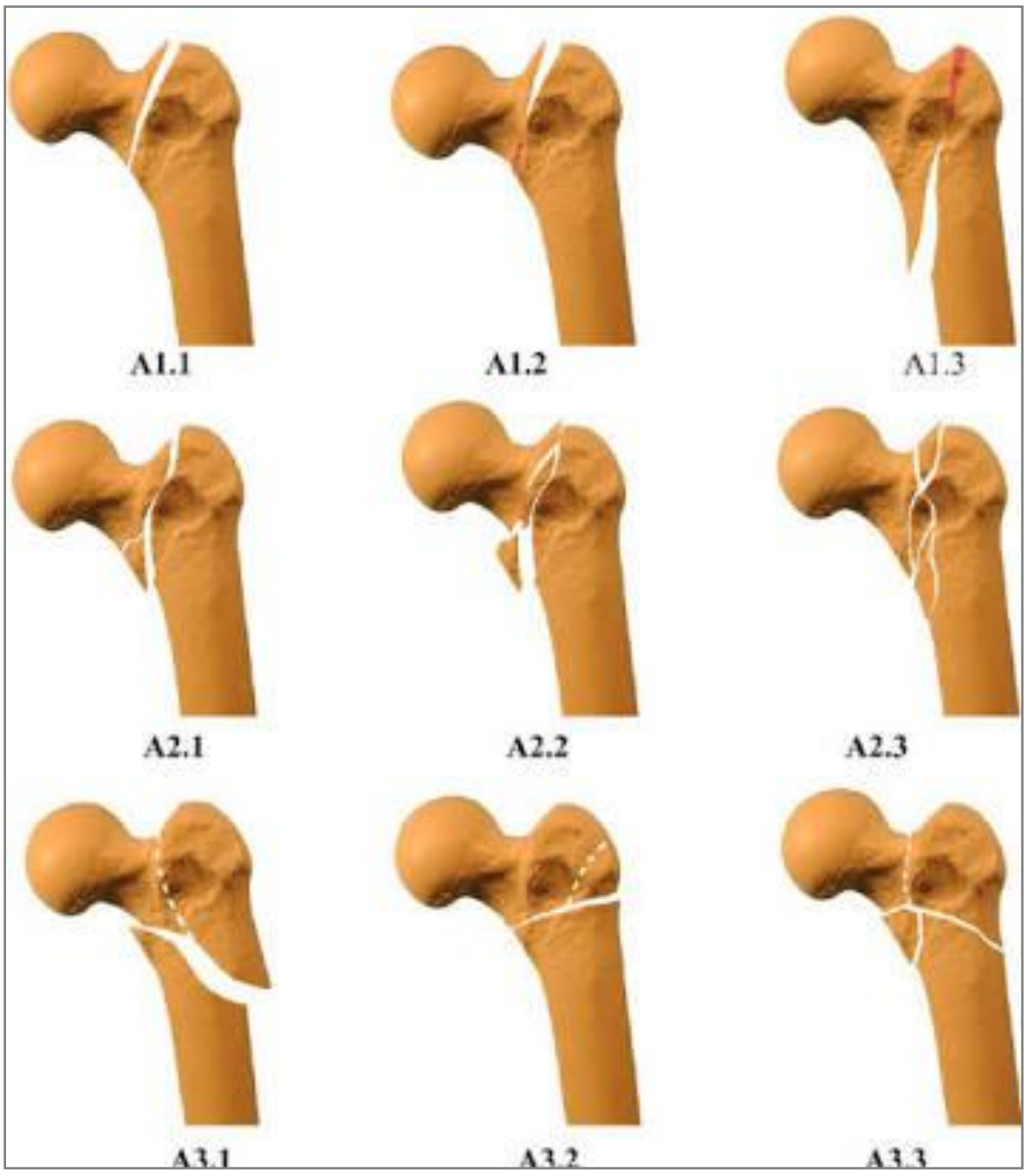
RAMADIER CLASSIFICATION [45]

RAMADIER CLASSIFICATION

A. Cervico-trochanteric fracture with fracture line at base of neck
B. Simple pertrochanteric fracture,often lesser trochanter is broken off.
C. Complex pertrochanteric fracture,greater trochanter is separated from femoral shaft
D. Pertrochanteric fracture with valgus displacement
E. Pertrochanteric fracture with intertrochanteric fracture line.
F. Trochantero-diaphyseal fractures
G. Subtrochanteric fracture.

AO CLASSIFICATION:

Muller in 1990 ha classified the trochanteric fractures into stable and unstable fractures. The stable trochanteric fractures have an intact medial buttress comprising 70% of the cases. The unstable types have large posterior fragment in addition to the medial fragments. They emphasize that for stability,the medial and posterior cortex should be intact. In treatment of unstable trochanteric fractures medial buttress should be reconstructed before fixation with an implant[35].


A1.1
A1.2
A1.3
A2.1
A2.2
A2.3
A3.1
A3.2
A3.3

Type A1:

Pertrochanteric simple(the typical oblique fracture line extending from greater trochanter to medial cortex,lateral cortex of the greater trochanter usually remains intact-two fragments)

A1.1: along the intertrochanteric line

A1.2: through the greater trochanter

A1.3: below the lesser trochanter

Type A2:

Pertrochanteric multi-fragmentary (the typical oblique line extending from greater trochanter to medial cortex,lateral cortex of the greater trochanter usually remains intact-separate posteromedial fragments)

A2.1: with one intermediate fragments

A2.2: with several intermediate fragments

A2.3: extending more than 1cm below the lesser trochanter

TYPE A3:

Intertrochateric fracture line extends across both medial and lateral cortices.

A3.1:simple oblique(reverse obliquity pattern)

A3.2:simple transverse

A3.3:multiple-fragmentary

KULKARNI CLASSIFICATION:

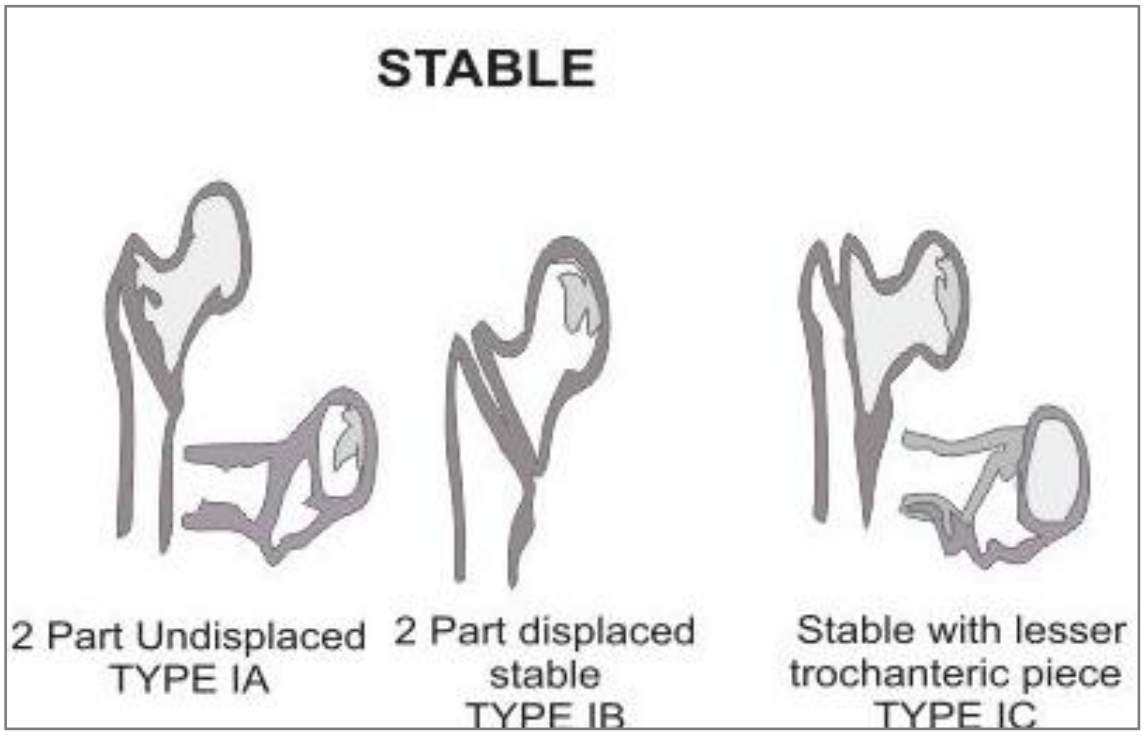
Using Evan-Jansen's and AO/OTA classification and by adding new varieties described by Gotfried and kyle,Kulkarni et al have presented a new treatment oriented classification in 2006[36].

STABLE:

Type I A: Stable undisplaced, 2 stable piece fracture

Type I B: Displaced, reducible, stable,2 part fracture

Type I C: Displaced but reducible, stable fracture type with small piece of lesser trochanter.

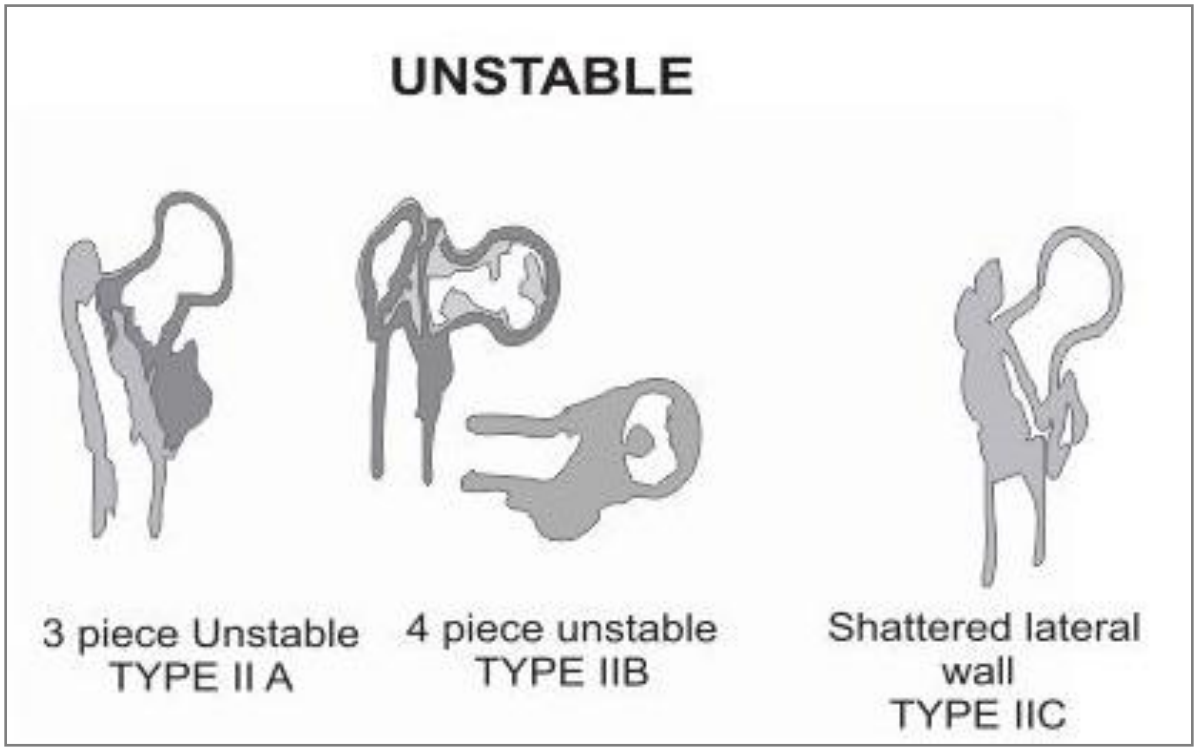


UNSTABLE:

Type II A: Unstable 3 piece fracture with large posteromedial fragments of lesser trochanter.

Type II B: 4 piece fractures

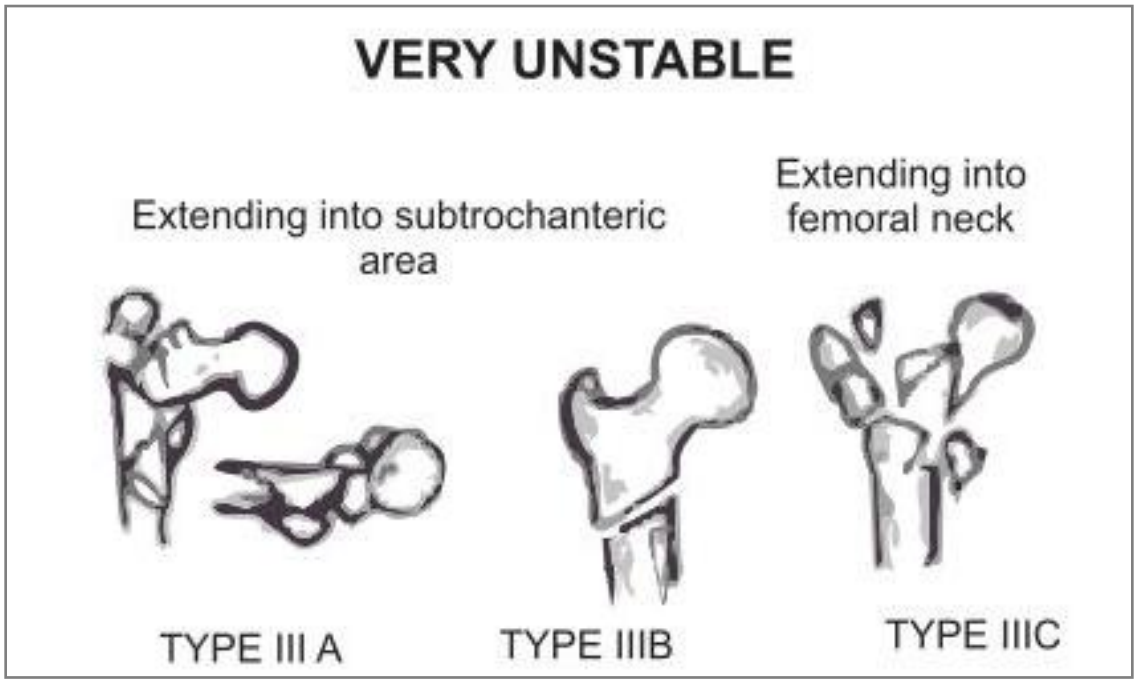
Type II C: Shattered lateral wall



VERY UNSTABLE:

Type III A: Trochanteric fracture with extension into subtrochanter

Tpye III C: Trochanteric fracture with extension into femoral neck area



PRINCIPLES OF MANAGEMENT:

Low energy falls from standing height is the most common mode of injury for these fractures. These fractures are commonly seen in patients older than 50 years of age. High energy fractures are relatively rare and if it occurs they are common in men less than 40 years of age. **Cummings** in 1989 hypothesized that four conditions were correlated for fall to cause a hip fracture[38].

1. Patient who falls will be oriented to impact around hip
2. All the protective responses must fail
3. Lost soft tissues should absorb less energy than necessary to prevent fracture to occur.
4. Residual energy of fall applied to proximal segment must exceed its original strength.

   This concept applies primary for strategies in preventing hip fractures.Fall with rotational component is more commonly seen with extracapsular fractures.

In some instances patients also present with distal radius, proximal humerus and minor head injuries associated with low energy falls. High energy fractures are commonly associated with ipsilateral extremity trauma, pelvis fractures and head injuries. Premorbid diseases may also co-exist with fracture diagnosis. Syncopal attacks resulting fall should focus attention on neurological and cardiovascular disease states. Any primary neoplastic or metastatic disease may reveal preceding hip pain and subsequent fall results in fracture.

HISTORY AND PHYSICAL EXAMINATION:

Patients present with history of pain and inability to weight bear over the affected lower limb following a fall or other injury. Pain is localized to proximal thigh region and is exacerbated by either passive or active attempts of hip movements. A displaced trochanteric fracture shows a classical findings of limb shortening and external rotation deformity in resting position when compared with contralateral extremity. Pain with axial compression on the hip has high correlation with occult fracture. Auscultation Lippmann test is a sensitive method to detect any occult fractures of pelvis or proximal femur in 1939.By placing stethoscope bell on symphysis pubis and tapping on patella of both lower limbs, variations in sound conduction discontinuity. A decrease in tone or pitch implies fracture with in arc of bone[40].

High risk potentially preventable complications such as deep vein thrombosis, pulmonary embolism, anti-coagulation medications, immune deficiency disorders,angina or cerebrovasclar accidents, atherosclerotic disease, any active infection are to be evaluated.

IMAGING AND OTHER DIAGNOSTIC MODALITIES:

Plain radiographs of AP view of pelvis, AP and cross table lateral view of the affected hip are usually asked for diagnosis and preoperative planning. **Koval KJ el al** in 2008 has said that traction views are helpful in communication and high energy fractures for determining implant selection. Subtrochanteric fractures require full length femur AP and lateral radiographs for implant length selection. If long nail implants is selected, AP

and lateral radiographs of affected proximal femur to knee are required with attention to femoral bow and medullary canal diameter.Traction with internal rotation views may benefits preoperatively for aiding in selection of definitive internal fixation[41].

Rizzo PF in 1993 stated that CT and MRI are required in diagnosis of a non-obvious and atypical fractures in high energy trauma patients. In many institution fluoroscopic C-ARM views in the operating rooms has reduced the need for preoperative lateral radiographs[42,43].

STABLE INTERTROCHANTERIC FRACTURE:

The fracture runs from the greater trochanter obliquely downwards and medially to exit just above the lesser trochanter. A good portion of the calcar is attached to the the proximal fragment anteromedially. Quite commonly there is an avulsion fracture of the lesser trochanter. As a rule the distal fragment is in external rotation. Rarely, the inferomedial spike of the proximal fragment is impacted into the metaphysis of distal fragment. An avulsion does not result in instability because it does not weaken the medial buttress.

UNSTABLE INTERTROCHANTERIC FRACTURE:

An unstable intertrochanteric fracture has characteristics that predispose to displace even after reduction and fixation has been achieved. If displacement is minor it results in minimal limb shortening. Severe displacement however can cause a well placed fixation device to cut out of femoral head and damage the acetabulum.

Litchblau in 2008 also added that displacement can also result in malunion, nonunion and failure of fixation device[37]. Occasionally the fracture has a reverse course beginning laterally and distally and running upwards and medially. Medially it exits above the lesser trochanter. Commonly it is associated with a fracture of the greater trochanter.

Unstable intertrochanteric fractures can often be recognized during physical examination. An intertrochanteric fracture that presents with a severely shortened or internally rotated limb is an unstable fracture. Radiographs will certainly show displacement, comminution and reverse obliquity.

According to **Watson et al** in 1998,stable trochanteric fractures are commonly treated with Dynamic hip screw fixation with failure rate less than 2%[44].The treatment of unstable trochanteric fractures is more controversial and has got multiple modalities of treatment with no clear cut guidelines.

HISTORY AND EVOLUTION OF TREATMENT

Internal fixation in treatment of intertrochanteric fractures has gained world -wide acceptance.

The general approach towards these fractures consists of various methods of closed reduction, traction and immobilization.

In 1800, potts and copper advocated supporting thigh in flexion, early mobilization from bed rest to chair and then to ambulation with support was the primary

goal in the treatment of these fractures. They have proposed benign neglect of fracture in attempt to save life over limb[4]. Hugh owen Thomas from Liverpool in 1890 advocated prolonged immobilization and bed rest[5].

FIG: SMITH-PETERSON NAIL

Although, **Von Langenbeck** first reported an open reduction and internal fixation of a fractured hip in 1878[6], it was **Smith Peterson's** refinement of surgical approach and introduction of the Triflanged nail, 40 years later that operative treatment became a better practical alternative[7].The problems and disadvantages with fixation by wires,threaded wire pins and screw apparatus has rapidly sent them out of practice in

treatment of these fractures.Whitman in 1902 advocated reduction, stabilisation with traction, internal rotation and abduction to restore the anatomy instead of benign neglect[8].The limb was maintained in long leg spica cast to maintain reduction.

FIG:JEWETT NAIL

In 1937,**Thornton** devised a plate attachment to the S.P.Triflanged nail so that trochanteric fractures could be fixed better.In 1941, Jewett developed a single piece angled nail.The Jewett nail with a few minor structural changes was proven acceptable[10].A simplified design in the form of a "V" nail was introduced in 1944 by **Neufeld**.[12]

In the same year **Austin Moore** designed his blade plate for trochanteric fractures but its use was short lived for this fracture because of the superiority of other nails. In 1947, **McLaughlin** engineered a variable angle nail plate, the advantage of which was the ease of adaptation of plate to the femoral shaft after the nail has been driven inside.

FIG: SMITH PETERSON NAIL AND MC LAUGHLIN SIDE

In 1938, **Godey-Moreira** reported 10 fractures treated with a cannulated “stut bolt screw” which impacted the fragments. Perfect results were obtained in 7of the 8 patientss followed.

Richardson who invented trochanteric buttress plate at Campbell clinic was first reported by **Boyd and Griffin** in 1949 to prevent the medialisation with neufeld plate in unstable fractures.Boyd also reported few refinements to the buttress technique by adding screw fixation into the trochanter[14].

In 1955, **Schumpelich and Jantzen** described the use of a sliding screw, the design which they attributed to Ernst Pohl[7].

In 1964, **Clawson** reported on treatment of trochanteric fractures using Sliding hip screw and plate. The device was developed independently at Richard's manufacturing company. Clawson made further modifications and in its current form the device is known as Richard's compression hip screw[15].

In recent years,the sliding hip compression screw system has become a widely accepted method of internal fixation for trochanteric fractures.

Valgus osteotomies were popularized by **Dimon and Houston, Harrington, Sarmiento** and others in 1960's to increase the stability of unstable fractures. Prospective studies, meta-analysis compared the results of sliding hip screw and osteotomies has shown no functional improvement with osteotomies and infact a higher risk of blood loss[16,17,18,19,20,21].

This stabilization of trochanteric fractures by remotely introduced medullary implants was first recommended by **Lezius, Kuentscher** and later **Simon Weidner** and especially **Ender** advanced in this direction and refined this method[22].

The Percutaneous compression plating system by the **Gotfried** in 1980 is a new method of managing intertrochanteric fractures in which it is composed of a plate, two telescoping neck screws and three shaft screws. The plate is specially designed to pass through soft tissues and to glide along the femoral shaft.This system permits percutaneous screw fixation and fracture site compression[23,24].

CH Marsh in 1983 has proposed the use of enders nail in management of intertrochanteric fractures[47]. Early fixation failure, leg shortening and external rotation deformities due to uncontrolled fragmentary collapse has questioned their use in unstable intertrochanteric fractures.

In 1980 – 1990 **Medoff** introduced biaxial compression hip screw for unstable intertrochanteric fractures. This was proven effective to minimize implant failure but with increased limb length discrepancy[47].

COMPRESSION HIP SCREW

MEDOFF SLIDING PLATE

In 2002 **Janzing HM, Huben BJ** stated that percutaneous compression plating system intertrochanteric fractures are a minimal invasive technique with reduced operative time and post operative pain than fixation with sliding hip screw[28].

In 2003 **Hardy D C** stated that a slotted intramedullary hip screw nail reduces the the proximal mechanical unloading on the femur[29].

In 2006 **N K Karan, G K Singh** proposed external fixator as a treatment modality for intertrochanteric fracture. In their study they stated that less amount of operative time, minimal blood loss were the potential advantages with this line of management[30].

In 2007 **Yechiel Gotfried** proposed that integrity of lateral femoral wall in intertrochanteric hip fractures are a predictor for reoperation in trochanteric fractures[31].

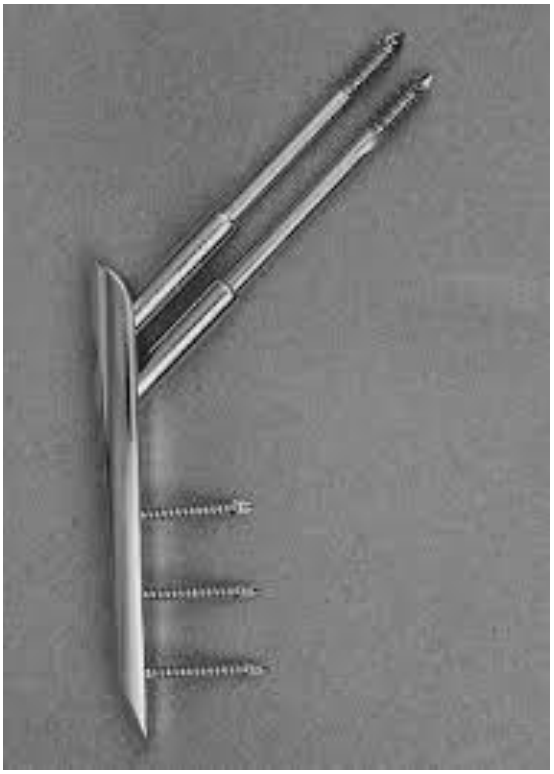
The long list of devices that have been used to stabilize these type of fractures is a testimonial to the fact that many did not do well.Thus there is continuing efforts being made to improve the design and materials of fixation devices.

SURGICAL OPTIONS FOR TROCHANTERIC FRACTURES:

Surgical options for trochanteric fractures included plate screw constructs, nail or screws for head fixation, nail constructs with screws, external fixation devices and arthroplasty.

Plate constructs are grouped into four functional types:

- Impaction class
  - Blade plates
  - Fixed angle nail plate device
- Dynamic compression class
  - Standard sliding hip screws
- Linear compression class: Multiple head fixation components controlling translation and rotation but allow linear compression.
  - Gotfried PCCP
  - Inter TAN CHS
- Hybrid locking class : Most stable type of fixation.Initially provides compression for fracture reduction with multiple fixation components followed by locking screw to prevent further axial compression.
  - Proximal femoral locking plates



PERCUTANEOUS COMPRESSION DEVICE

Fixed angle plating are commonly used for corrective osteotomies instead of primary treatment of hip fractures[21].**Chinoy et al** in their meta-analysis of 2855 patients compared accurately fixed nail plate constructs with sliding implants.They concluded that there was increased risk of cutout (13% vs 4%),implant breakage (14% vs 0.7%),non-union (2% vs 0.5%) and reoperation (10% vs 4%) for fixed angle nail plates in comparison with sliding implants.

CEPHALOMEDULLARY DEVICES:

These devices are inserted through piriformis fossa, lateral greater trochanter and medial greater trochanter.The femoral head portion of construct consists of one or more screw and blade device interlocked with nail components. Most commonly indicated in pertrochanteric and sub trochanteric fractures. In piriformis entry nail the shaft component is laterally angulated proximally. In 2008 Russel classified[48] cephalomedullary nail constructs in order of invention as :

1. Impaction class or Y nail class
2. Dynamic compression or Gamma class-Large head nail component with a single large lag screw.
3. Reconstruction class with a smaller head diameter and using two lag screw which are independent of each other.
4. Integrated class : Provides linear compression at fracture site.Developed by Russel and Sanders.

Class	Examples	Failure Modes
Impaction	Y-Nail,TFN	Medial penetration
Dynamic compression	Gamma,IMHS	Cutout, Peri-implant failure with short designs
Two-screw dynamic compression	Reconstruction	Z-effect
Linear compression integrated	InterTAN	Unknown

A. Short trochanteric fixation nail (TFN)

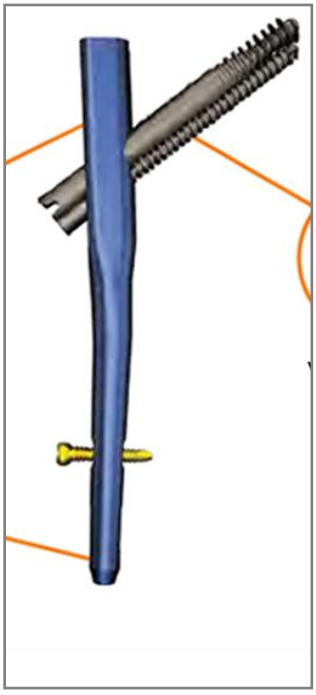
B. Short gamma 3 intramedullary nail

C. Short trochanteric antegrade nail

D. Short InterTAN cephalomedullary nail

E. Short intramedullary hip screw (IMHS)

SHORT TROCHANTERIC ANTEGRADE NAIL



SHORT InterTAN CEPHALOMEDULLARY NAIL

SHORT INTRAMEDULLARY HIP SCREW

SHORT GAMMA 3 INTRAMEDULLARY NAIL

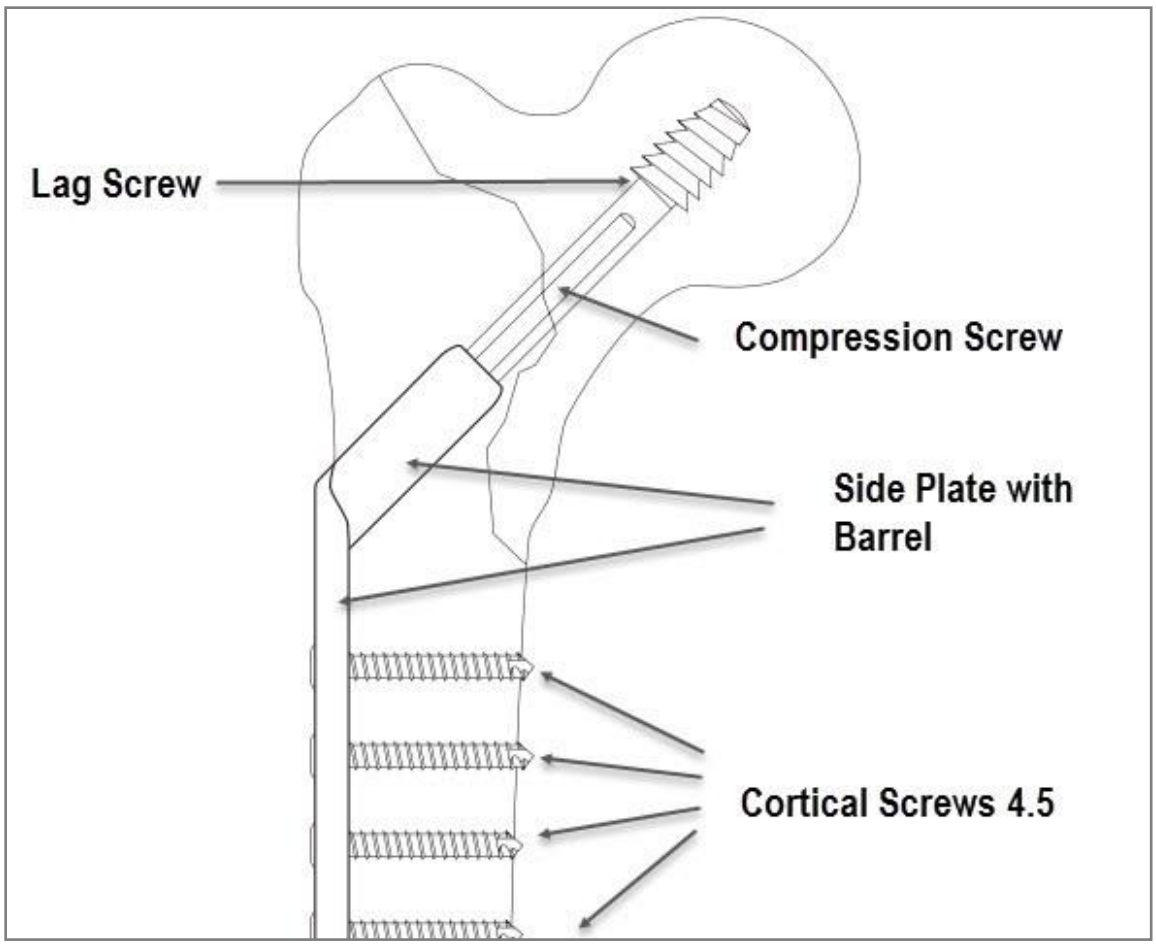
Dynamic Hip Screw

Dynamic hip screw or Sliding Screw Fixation is an implant assembly consisting of a lag screw, a sideplate and cortical screws which fix the side plate to the proximal femoral shaft.

The lag screw is a thick screw which is inserted into the head of femur from lateral aspect of proximal femur.

The sideplate has angled barrel which glides over the distal part of the screw and the side plate is fixed to the proximal femur with help of cortical screws.

Dynamic hip screw is used in fixation of proximal femur fractures mainly intertrochanteric fractures, but can also be used in selected cases of fractures of femoral neck and subtrochanteric fractures



Biomechanics of Dynamic Hip Screw

To understand the principle of fixation behind dynamic hip screw, we need to go to their history of development.

Earlier, angled blade plates were used to fix intertrochanteric fractures and other proximal femoral fractures. These implants were of static kind as compared to dynamic nature of sliding hip screw assembly.

These angled blade plates had a fixed angle to match the neck shaft angle. One part of these plates were inserted into lateral cortex of proximal femur and passed along the neck to take final purchase into the head.

The distal part was fixed to the femoral shaft by screws.

Apart from other issues like failure of purchase and frequent need for osteotomies to accommodate the plate, a major concern was that these plates did not allow any compression across the fracture site as the rigid unibody assembly did not allow any movement.

It led to stress failure of the implant and frequent non unions as no compression was allowed after surgery was done.

Dynamic hip screw or sliding hip screw is a unique assembly. The screw can slide in the barrel of the plate. Therefore when the person bears weight, the screw slides and comes along and the proximal fragment compresses on to the distal fragment.

Thus idea behind the dynamic compression is that the femoral head component is allowed to move and fracture fragments come together for better healing.

The side plate via its barrel provides strong support to the sliding screw and allows it to collapse in a controlled manner.

Parts of Dynamic Hip Screw

1. Lag Screw

Lag screw is a special screw after which the DHS gets its name of dynamic hip screw or sliding hip screw.

The screws are available in various lengths of 50 to 145 mm to match the neck length across the population. It has a thread diameter of 12.5 mm and thread length of 22 mm.

Shaft is slotted to fit the barrel and has a diameter of 8.0 mm. Keyed screw system prevents unwanted rotator movements. The shaft and barrel slots fit each other so that the screw is able to slide into the barrel but cannot rotate.

On the distal aspect of shaft of the lag screw, inner side is threaded. This is for placing compression screw after the screw and plate assembly has been fixed.

The purpose of the Richards compression screw is to pull the lag screw towards barrel as the compression screw is tightened.

Short barrel dynamic hip screw side plate is preferred when screw < 80 mm . In such cases, the screw prevents disengagement of assembly.

The lag screw length to be used is measured with gauge. This measurement allows for 5 mm of compression. If more compression is desired, use a shorter screw. A screw 5 mm shorter permits 10 mm of compression.

2. Side Plate

Side plates are available with a plate barrel angle 130°–150°.

The barrel plate angle matches the neck shaft angle. Therefore variable angles are designed to match the angle in different persons.

However, 135 degrees is most commonly used.

The plates are available in sizes varying from two holes to 16 hole.

The plate is 5.8 mm thick and 19mm wide. Holes are spaced at 16mm.

Only two types of Barrel lengths are present, they are short barrel(25mm) and standard barrel(38mm)

Technique of Dynamic Hip Screw

For this surgery, a C-Arm is required to check for guide wire and screw positioning.

Usually the surgery is performed for intertrochanteric fractures. Most of them could be treated closed.

The majority of intertrochanteric hip fracture can be reduced closed on a fracture table.

Occasionally, however, an open reduction may be necessary to achieve adequate fracture alignment.

The size of hip screw measured preoperatively on the x-ray to get an idea about probable size to be used.

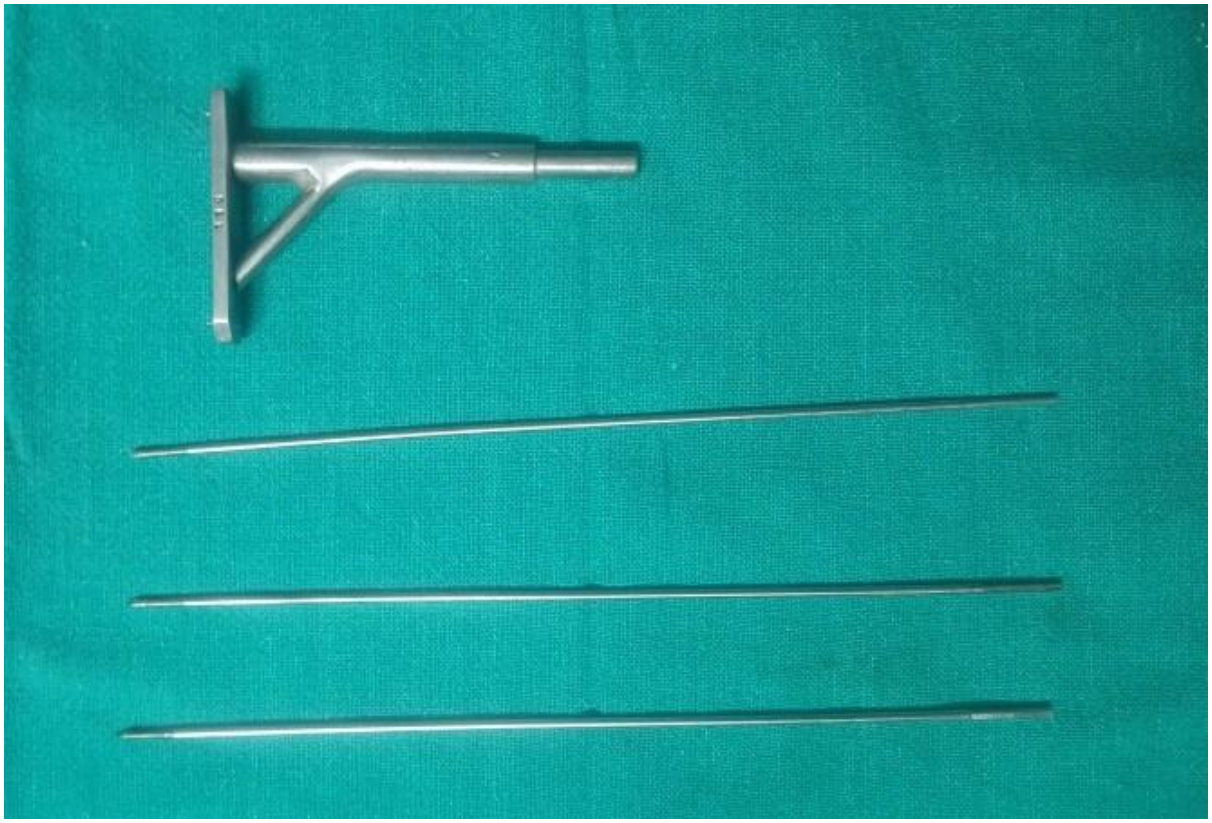
The patient is supine on the fracture table with feet padded and placed firmly in fracture table boots . Contra-lateral leg is either dropped down or raised on a 90° thigh holder.

There should be enough padding into groin and genitals to be protected.

Ipsilateral arm is taped over the chest.

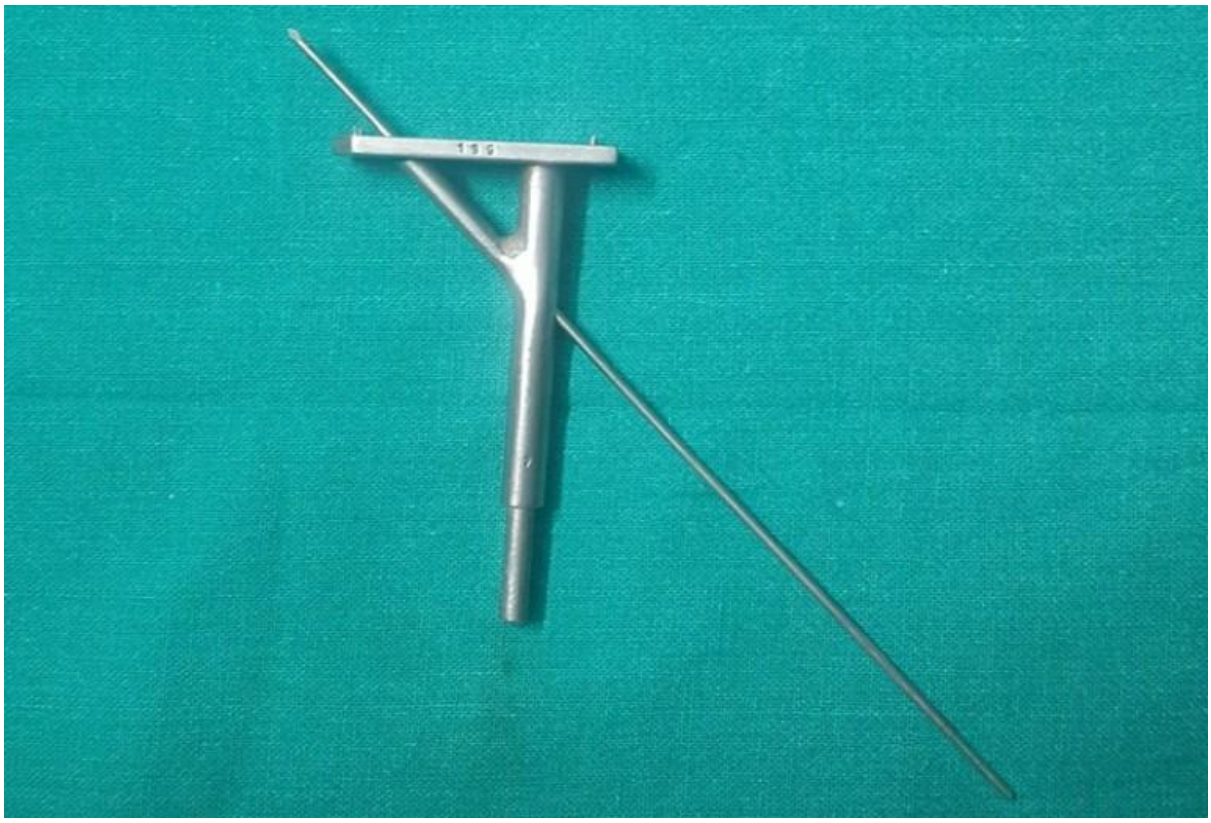
After preparation of the parts, the proximal femur is exposed through an incision extending from the greater trochanter to approximately 8-10 cm distaly.

The lateral femur is exposed, and a guide wire is drilled from the lateral femur into the femoralhead.



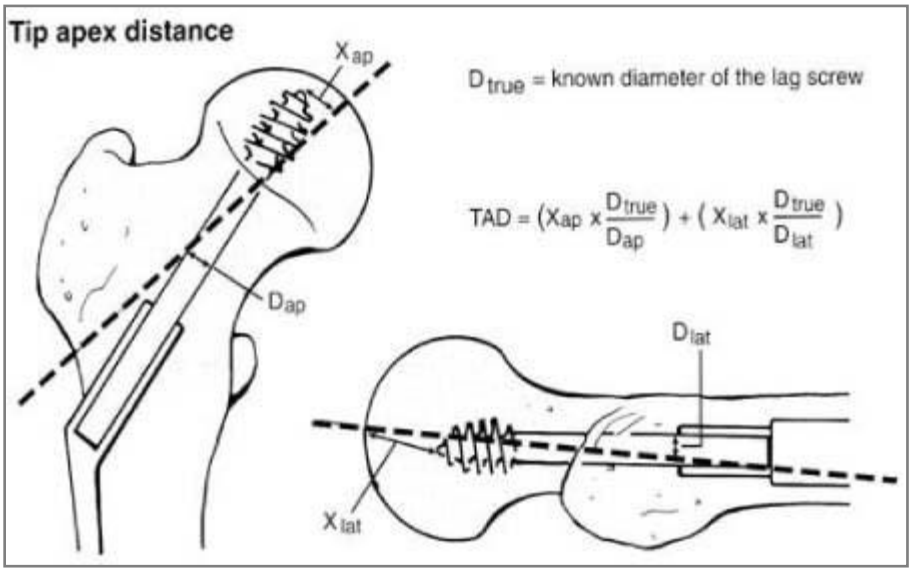
Guide Wires and targeting device

The guide wire should be centered in the femoral neck in both the lateral view and the AP view.



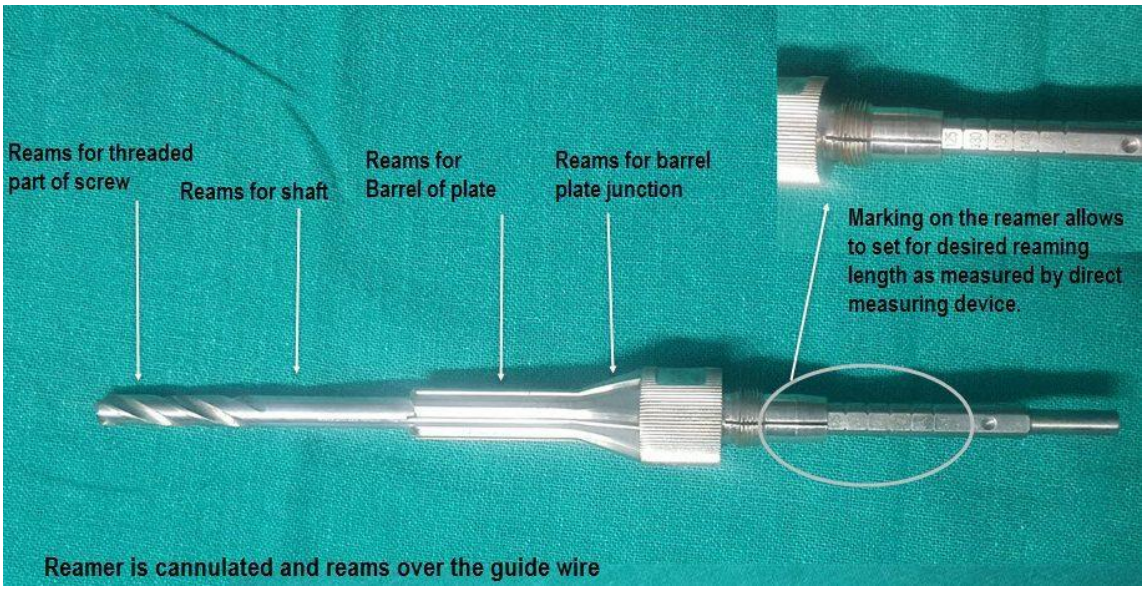
The angle between the wire and the femoral shaft must equal to the angle of the proposed fixation device (usually 135°). The tip of the guide wire must lie in the center of the femoral head and 1 cm from the subchondral line on both the AP and lateral views.

***Tip Apex* Distance**

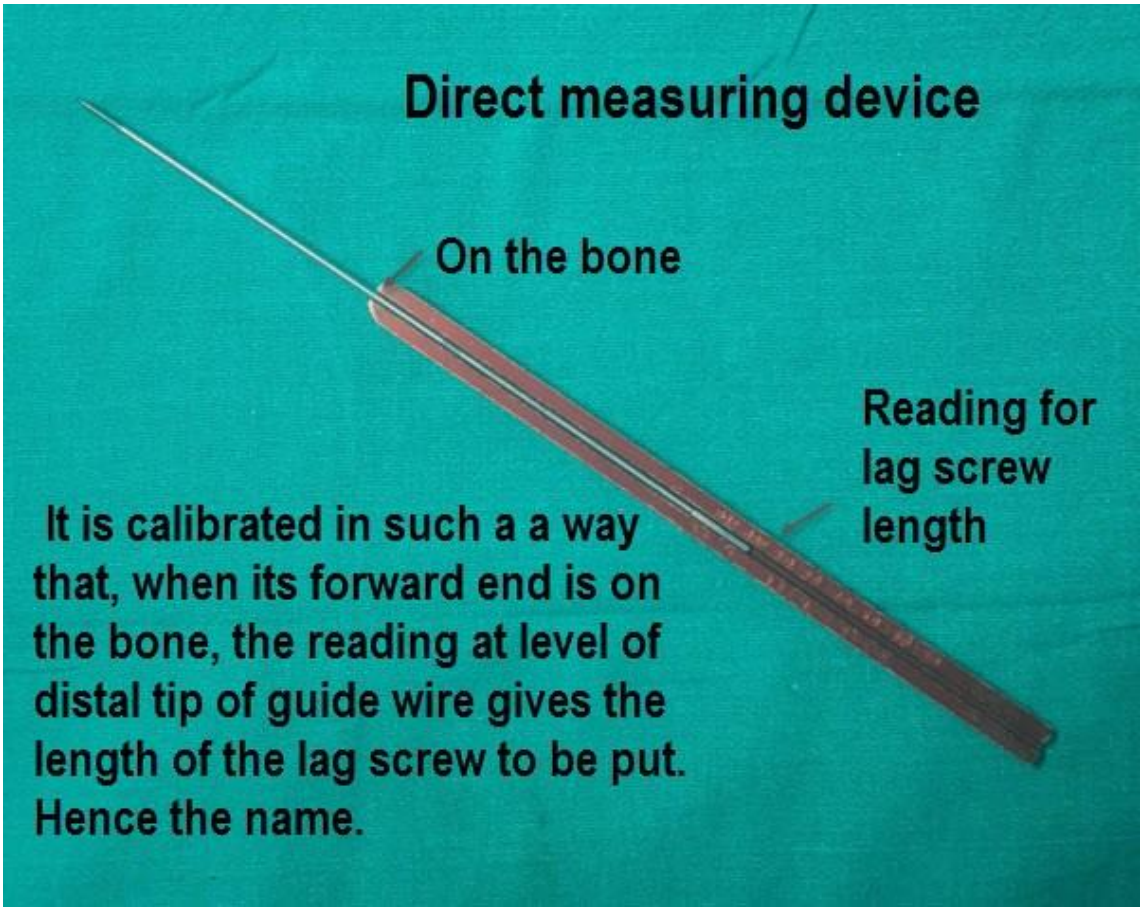


A helpful concept regarding this position is Baumgaertner's tip apex distance, the sum of the distances from the tip of the lag screw to the apex of the femoral head, measured on both the anteroposterior and the lateral radiographs, this is the tip apex distance. The TAD must be less than 2.5 cm for a minimal screw cutout.

After the guide wire is confirmed to be in place, the cannulated reamer [also called triple reamer] is used to drill over the already placed guide wire till the tip of the wire.

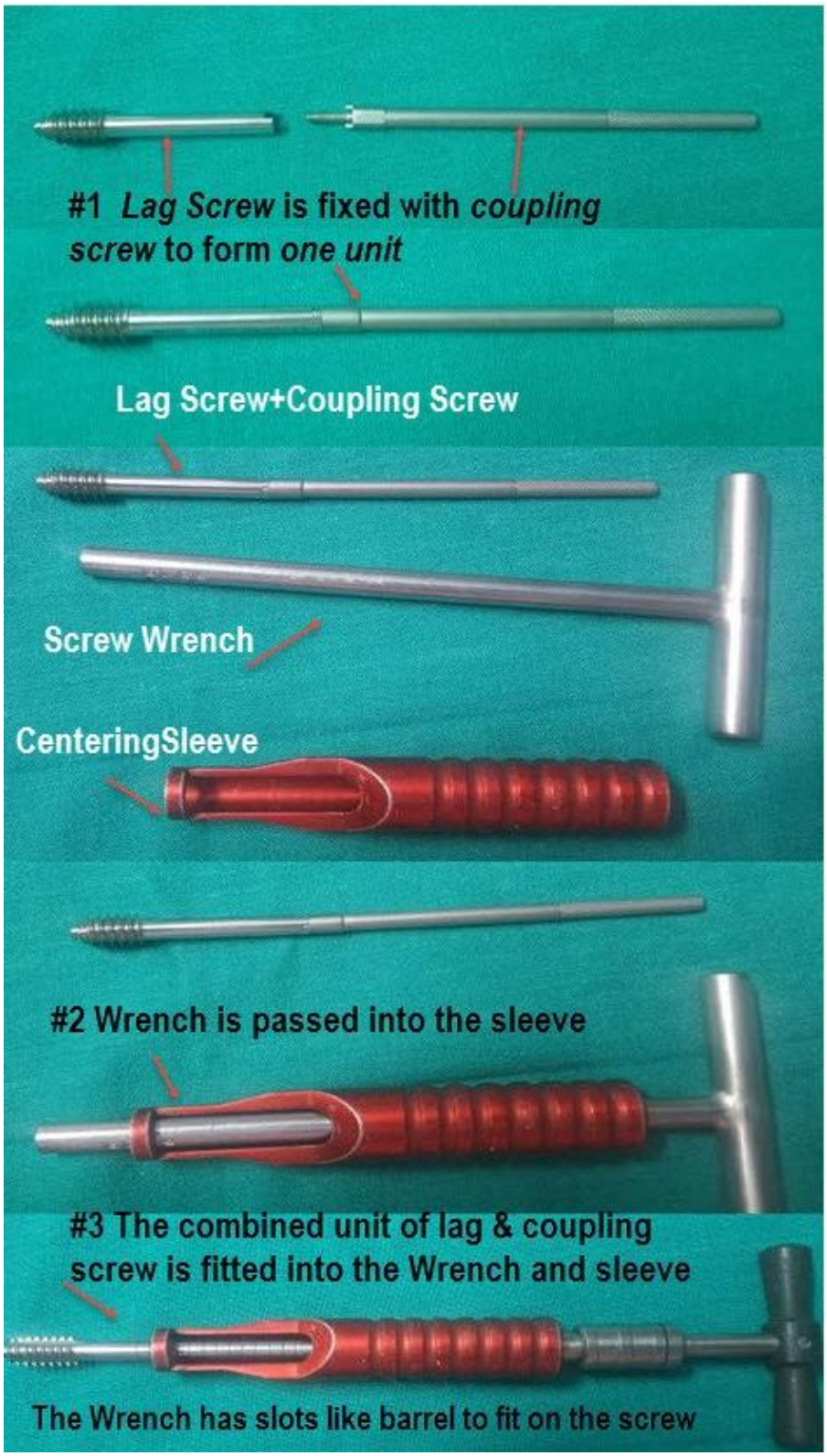


The reamer is set to the correct depth as measured on table by direct measuring device.



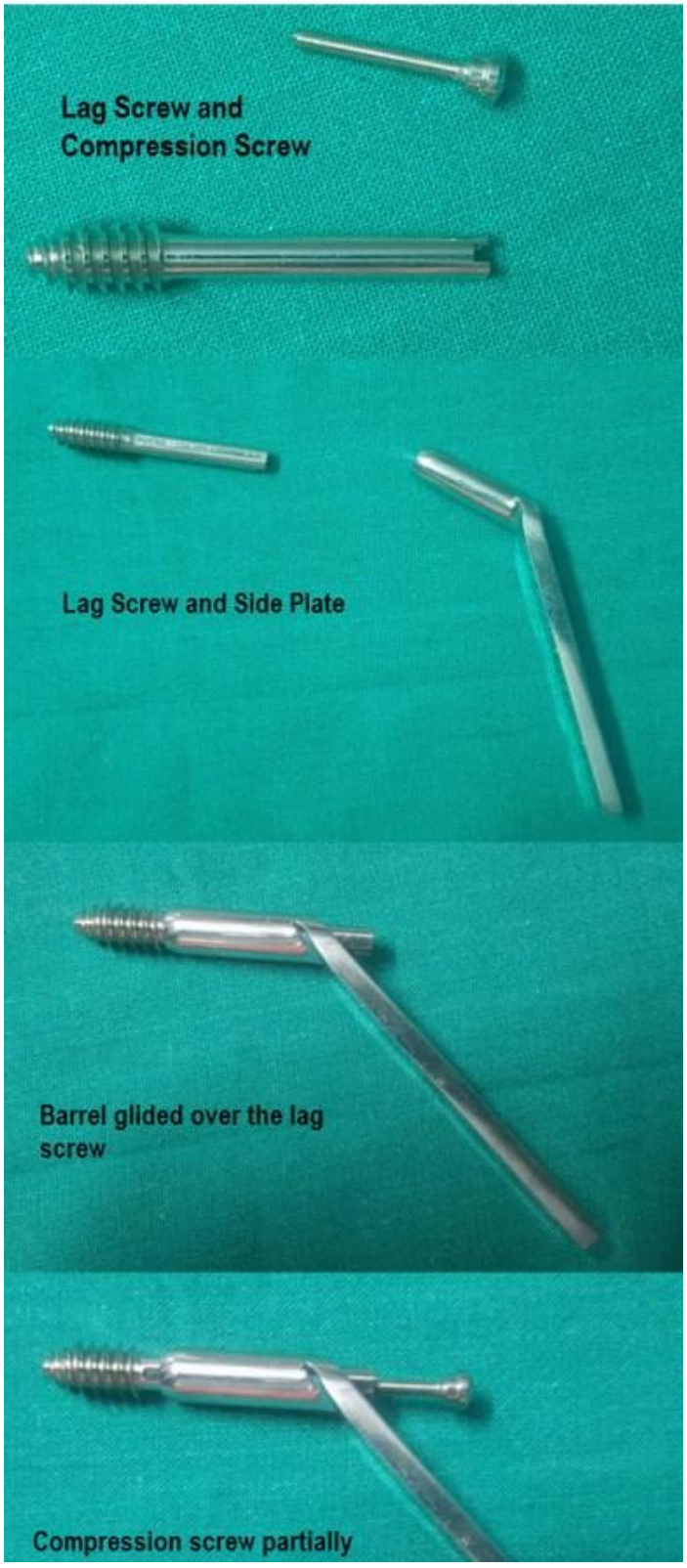
The lag screw is inserted into the femoral head after tapping of the drilled channel.

LAG SCREW ASSEMBLY



The side plate and barrel are placed over the screw and attached to the femoral shaft with the appropriate screws. Fluoroscopic images are taken throughout the repair to ensure the maintenance of the reduced fracture position and the proper positioning of the fixation device.

Lag Screw and Plate Assembly



Depending on the bone strength, two hole to six hole plate is used in intertrochanteric fractures. Longer plates are required in case of subtrochanteric fractures. It is desirable to obtain compression at the fracture site. For this, traction on the affected limb is released and compression screw is inserted. Wound is closed in layers.

MATERIALS AND METHODS:

The aim of this study is to assess fracture healing, collapse and implant failure, in unstable intertrochanteric fractures(boyd and griffin type-2) treated by modified DHS fixation. This modification is done by us in order to limit the collapse across fracture site.

Failures of Dynamic hip screw are due to over collapse, inability to maintain posterior-medial cortex continuity, inability to maintain anatomical relationship between fragments, inablity to position screw in the central zone and tip-apex distance <25mm[55].

Type of study:

Retro-prospective.

Sample size:

23 patients

Duration of study:

Jan 2015 to August 2017

Retro-Prospective study:

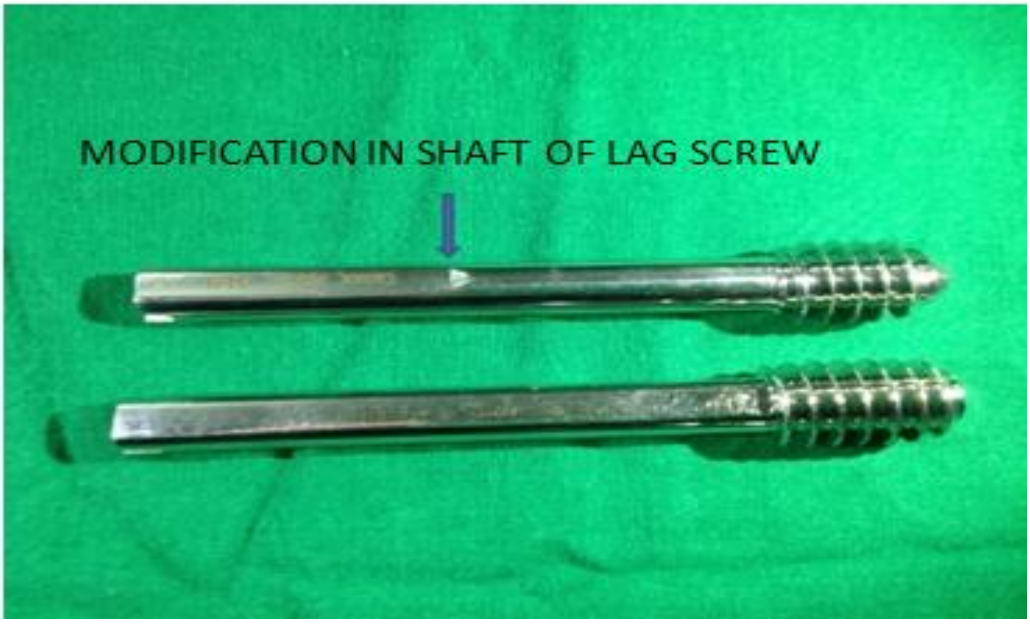
Patients with unstable intertrochanteric fractures admitted in PSG Hospitals affiliated to PSG institute of medical sciences and research who was operated by modified Dynamic Hip Screw fixation between Jan 2015 to Aug 2017.

Inclusion criteria:

- Boyd and griffin classification type-2 fractures only
- Patients willing for treatment and given written informed consent.

Exclusion criteria:

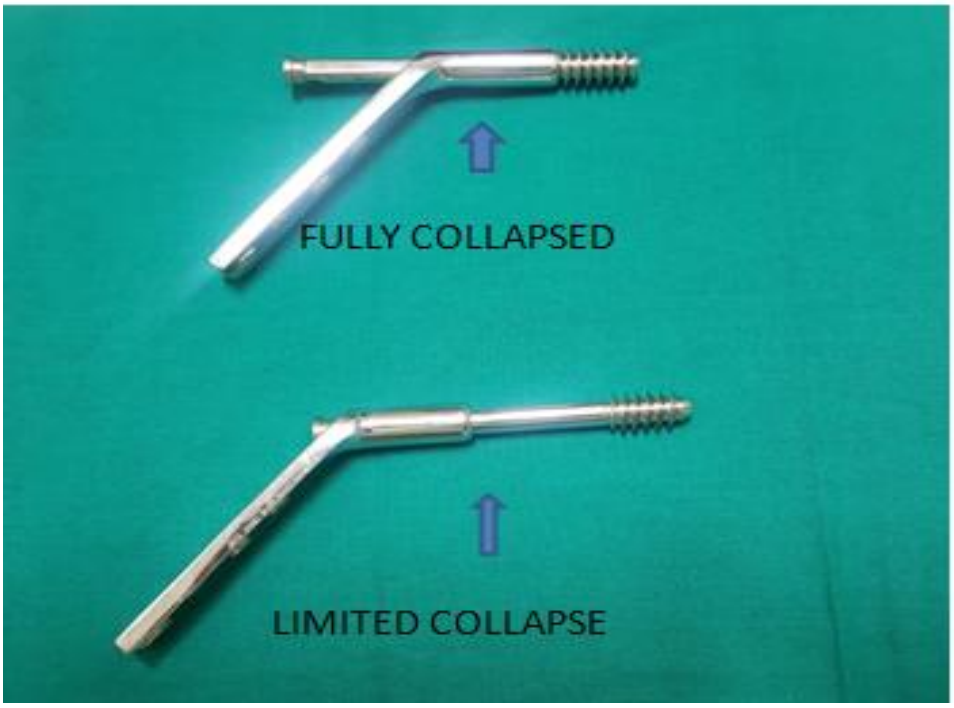
- Boyd and griffin classification type-1, type-3 and type -4
- Pathological fractures
- Infection
- Treated after 3 weeks of trauma.
- Patients medically unfit for surgery.
- Compound fractures associated with vascular injuries, ipsilateral femoral shaft fractures and pelvic fractures.
- Patients not willing for treatment.
- **ABOUT MODIFIED DYNAMIC HIP SCREW:**
- One of the cause for failure of Dynamic Hip Screw is over collapse at fracture site[55].
- In this study, we have used modified dynamic hip screw to limit the over collapse which is undesired in unstable intertrochanteric fractures.
- In this implant we have done modification in the shaft of lag screw, we have reduced the length of **keyed screw system**, so that we can have a maximum of 1 cm collapse, hence there will be limitation in collapse unlike the original implant.



Modified lag screw versus Normal lag screw

BEFORE COLLAPSE

Normal Dynamic Hip Screw versus Modified dynamic Hip Screw



AFTER COLLAPSE

Normal DHS fully collapsed VS Modified DHS limitation in collapse

METHODOLGY:

All type–2 boyd and griffin intertrochanteric fracture in this study underwent modified Dynamic Hip Screw fixation. All patients were placed in traction table and closed reduction achieved, lateral approach was used. The standard surgical technique was used. Post operative x-rays were analysed at first month, third month and fifth month follow-up.

The following factors were analysed in follow-up x-rays,

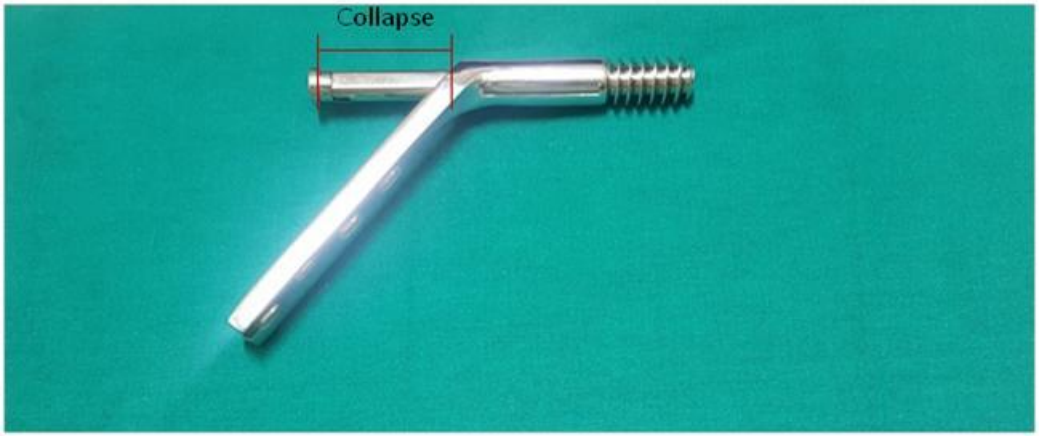
1. Fracture healing
2. Fracture collapse
3. Implant failure

FRACTURE HEALING:

Fracture healing was assessed by taking radiographs at first month, third month and fifth month or till complete healing. Cortical bridging was noted in x-rays to document fracture healing.

FRACTURE COLLAPSE:

Fracture collapse was assessed by calculating the distance between base of lag screw and side plate.



IMPLANT FAILURE:

Implant failure was considered when there was migration of implant, implant loosening , implant cut-out or non-union

RESULTS

In this retro-prospective study a total of 23 patients were assessed. Pre-operative AP radiographs of pelvis was taken for all the patients who were treated by modified dynamic hip screw fixation. All patients who underwent treatment were of age from 38 years to 90 years. Out of 23 patients in this study, 13 patients were male(56.5%) and 10 patients were female(43.5%). Only boyd and griffin type-2 fractures were taken in view of standardisation. Post-operatively follow up xray were taken at 1st month,3rd month and 5th month and the outcome was assessed.

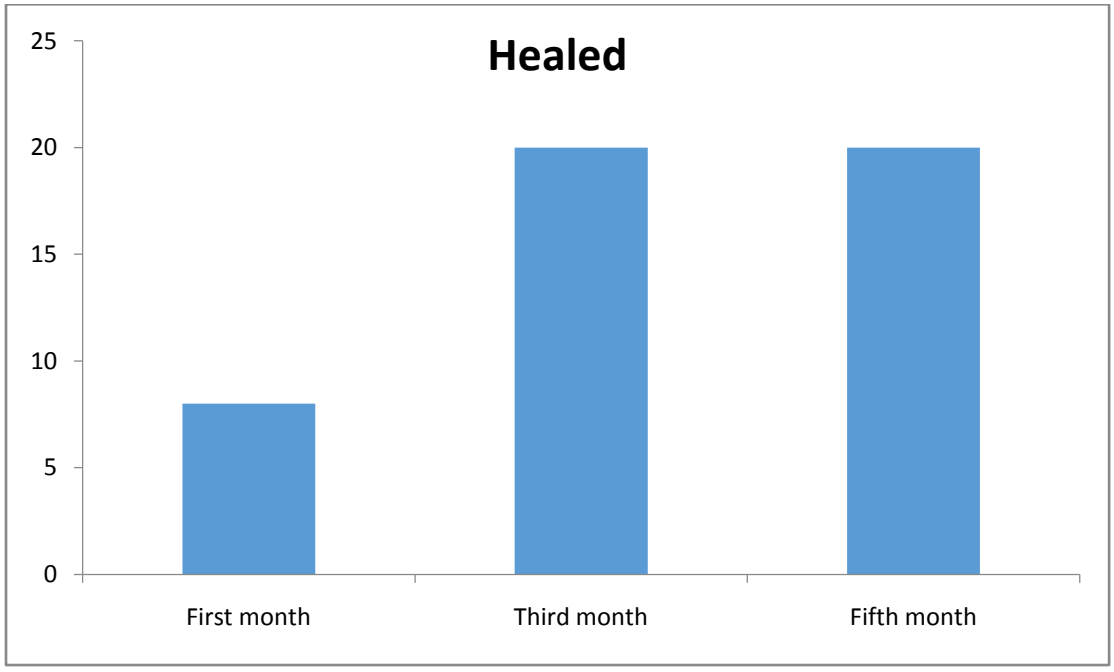
Factors assessed were

1. Fracture healing
2. Fracture collapse
3. Implant failure

FRACTURE HEALING:

	1st month	3rd month	5th month
Healed	8(34.8%)	20(87%)	20(87%)
No healing	15(65.2%)	3(13%)	3(13%)
Total	23(100%)	23(100%)	23(100%)

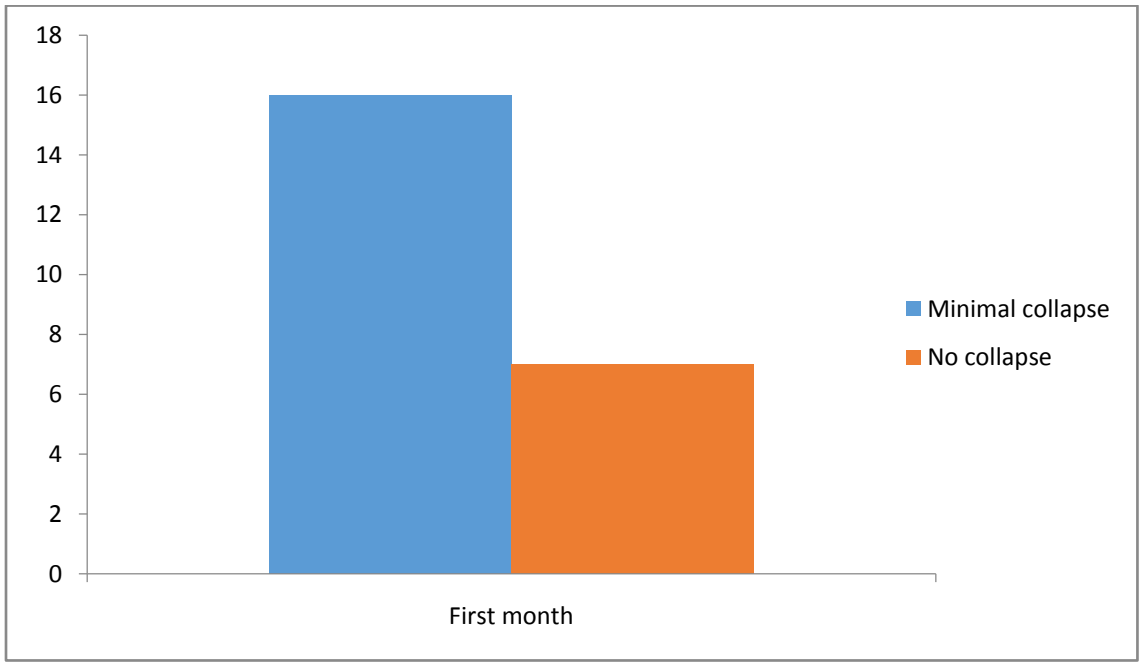
Out of 23 patients in this study, at first month follow-up, 8 patients showed fracture healing(34.8%) , at third month follow-up, 20 patients showed fracture healing(87%) , at fifth month follow-up, 20 patient showed fracture healing(87%) and three patient had non-union(13%)



FRACTURE COLLAPSE:

	1st month
Minimal collapse	16(69.6%)
No collapse	7(30.4%)
Total	23(100%)

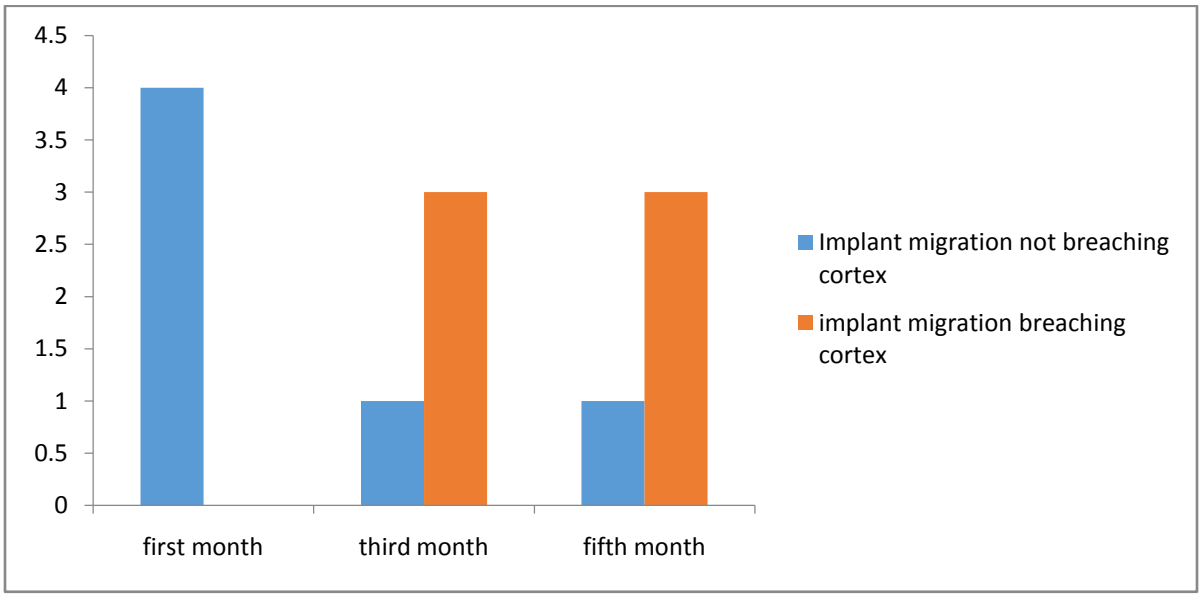
Out 23 patients in this study, at first month follow-up, 7 patients showed no collapse(30.4%) and 16 patients showed minimal collapse(69.6%) [less than 1 cm], however the collapse rate remained same for all patients till end of this study.



IMPLANT FAILURE:

	1st month	3rd month	5th month
No implant failure	19(82.6%)	19(82.6%)	19(82.6%)
Implant migration not breaching cortex	4(17.3%)	1(4.3%)	1(4.3%)
Implant migration breaching cortex	0	3(13.0%)	3 (revision surgery) (13%)
Total	23(100%)	23(100%)	23(100%)

Out of 23 patients in this study, 4 patient had implant migration not breaching cortex(17.3%). At third month , out of 4 patients who had implant migration, 3 patients had cortical breach (13.0%) and the other patient healed uneventful inspite of implant migration.3 patients who had implant migration breaching cortex underwent revision surgery(13.0%).



DISCUSSION

Intertrochanteric fractures are mainly treated by surgical intervention. Despite long term experience in many centres, there have been factors still contributing to poor outcome of managing unstable intertrochanteric fractures.

Controversies persist because there is lack of proper per-operative risk factors assessment that affect the outcome in these fractures treated by various methods.

Failures of Dynamic hip screw in unstable intertrochanteric fracures are due to over collapse at fracture site[55].

In this study , we have used modified Dynamic Hip screw for treating comminuted intertrochanteric fractures , we have used this implant to limit the over collapse at fracture site.

Fracture healing:

Out of 23 patients in this study, at first month follow-up, 8 patients showed fracture healing(34.8%) , at third month follow-up, 20 patients showed fracture healing(87%) , at fifth month follow-up, 20 patient showed fracture healing(87%) and three patient had non-union(13%).

Nordin S in their study on treatment of intertrochanteric fractures with Dynamic Hip Screw, 83.3 percent of patients had fracture healing at one month[56]. In our series only 34.8 percent of patients showed fracture healing at first month, , however at the end

of fifth month 87% fractures went on to heal. This delay in fracture healing relates to the modification in design of implant which limits the collapse at fracture site.

Fracture collapse:

Out 23 patients in this study, at first month follow-up, 7 patients showed no collapse(30.4%) and 16 patients showed minimal collapse(69.6%) [less than 1 cm], however the collapse rate remained same for all patients till end of this study.

No patient had a collapse of more than 1 cm. This is related to the design of implant whose modification allows collapse of less than 1 cm. No literature was available where amount of collapse at fracture site have been discussed.

Implant failure:

Out of 23 patients in this study, at first month follow-up, 19 patients showed no implant failure(82.6%), 4 patient had implant migration not breaching cortex(17.3%). At third month , out of 4 patients who had implant migration, 3 patients had cortical breach (13.0%) and the other patient healed uneventful inspite of implant migration.3 patients who had implant migration breaching cortex underwent revision surgery(13.0%).

The three patients who had implant failure was related to early weight bearing.

Sadowski cal et al in their study on treatment of unstable intertrochanteric fractures with sliding hip screw , implant failure and non-union was noted in 7 of 19 patients (38%) who had been treated with the sliding hip screw[50] . In our series, implant failure was noted in 3 out of 23 patients(13%).This results compare favourably

and highlights the advantage of modified Dynamic Hip Screw in treatment of communited intertrochanteric fractures.

CONCLUSION

Modified Dynamic Hip Screw has showed improved results as compared to normal Dynamic Hip Screw in treating communited intertrochanteric fracture.

- Fracture healing was slow in comparing with regular Dynamic hip screw.
- Modified Dynamic hip screw significantly limits the collapse at fracture site.
- When modified Dynamic Hip Screw is used in managed of communited intertrochanteric fracture, weight bearing mobilisation should be delayed to improve the outcome.

LIMITATIONS

- Small sample size
- Other forms of fixation of trochanteric fractures were not compared in this study.

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PSG Institute of Medical Sciences & Research
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To
Dr D Praveen
Postgraduate
Department of Orthopaedics
Guides: Dr B K Dinakar Rai / Dr S M Arvind Kumar / Dr M Venkatesh Kumar
PSG IMS & R
Coimbatore

Ref: Project No.15/410

Date: February 2, 2016

Dear Dr Praveen,

Institutional Human Ethics Committee, PSG IMS&R reviewed and discussed your application dated 21.12.2015 to conduct the research study entitled *"A modified DHS fixation in unstable intertrochantric fractures: A retrospective and prospective observational study"* during the IHEC meeting held on 24.12.2015.

The following documents were reviewed and approved:

1. Project Submission form
2. Study protocol (Version 1 dated 21.12.2015)
3. Informed consent forms (Version 2 dated 12.01.2016)
4. Confidentiality statement
5. Application for waiver of consent
6. Data collection tool (Version 1 dated 21.12.2015)
7. Permission letter from concerned Head of the Department
8. Current CVs of Principal investigator, Co-investigators
9. Budget

The following members of the Institutional Human Ethics Committee (IHEC) were present at the meeting held on 24.12.2015 at IHEC Secretariat, PSG IMS & R between 10.00 am and 11.00 am:

Sl. No.	Name of the Member of IHEC	Qualification	Area of Expertise	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
1	Mr. R. Nandakumar	BA., BL	Legal Expert, Chairperson	Male	No	Yes
2	Dr. S. Bhuvaneshwari (Member-Secretary, IHEC)	MD	Clinical Pharmacology	Female	Yes	Yes
3	Dr. S. Shanthakumari	MD	Pathology, Ethicist	Female	Yes	Yes
4	Dr D Vijaya	M Sc., Ph D	Basic Medical Sciences (Biochemistry)	Female	Yes	Yes

The study is approved in its presented form. The decision was arrived at through consensus. Neither PI nor any of proposed study team members were present during the decision making of the IHEC. The IHEC functions in accordance with the ICH-GCP/ICMR/Schedule Y guidelines. The approval is valid until one year from the date of sanction. You may make a written request for renewal / extension of the validity, along with the submission of status report as decided by the IHEC.

PSG Institute of Medical Sciences & Research
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Following points must be noted:

1. IHEC should be informed of the date of initiation of the study
2. Status report of the study should be submitted to the IHEC every 12 months
3. PI and other investigators should co-operate fully with IHEC, who will monitor the trial from time to time
4. At the time of PI's retirement/intention to leave the institute, study responsibility should be transferred to a colleague after obtaining clearance from HOD, Status report, including accounts details should be submitted to IHEC and extramural sponsors
5. In case of any new information or any SAE, which could affect any study, must be informed to IHEC and sponsors. The PI should report SAEs occurred for IHEC approved studies within 7 days of the occurrence of the SAE. If the SAE is 'Death', the IHEC Secretariat will receive the SAE reporting form within 24 hours of the occurrence
6. In the event of any protocol amendments, IHEC must be informed and the amendments should be highlighted in clear terms as follows:
   a. The exact alteration/amendment should be specified and indicated where the amendment occurred in the original project. (Page no. Clause no. etc.)
   b. Alteration in the budgetary status should be clearly indicated and the revised budget form should be submitted
   c. If the amendments require a change in the consent form, the copy of revised Consent Form should be submitted to Ethics Committee for approval
   d. If the amendment demands a re-look at the toxicity or side effects to patients, the same should be documented
   e. If there are any amendments in the trial design, these must be incorporated in the protocol, and other study documents. These revised documents should be submitted for approval of the IHEC and only then can they be implemented
   f. Any deviation-Violation/waiver in the protocol must be informed to the IHEC within the stipulated period for review
7. Final report along with summary of findings and presentations/publications if any on closure of the study should be submitted to IHEC

Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Thanking You,

Yours Sincerely,

SECRETARY
PSG IMS&R
COIMBATORE-641004
INSTITUTIONAL HUMAN ETHICS COMMITTEE

Dr S Bhuvaneshwari
Member - Secretary
Institutional Human Ethics Committee

PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee

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June 10, 2016

To
Dr D Praveen
Postgraduate
Department of Orthopaedics
Guide: Dr B K Dinakar Rai
PSG IMS & R
Coimbatore

The Institutional Human Ethics Committee, PSG IMS & R, Coimbatore - 4, has reviewed your proposal on 10th June, 2016 in its expedited review meeting held at IHEC Secretariat, PSG IMS&R, between 10.00 am and 11.00 am, and discussed your request to amend the study entitled:

"A modified DHS fixation in unstable intertrochantric fractures: A retrospective and prospective observational study"

The following documents were received for review:

1. Your letter dated 28.05.2016
2. Amendment reporting form

After due consideration, the Committee has decided to approve your request to take 6 X-rays for the participants of the above study.

The members who attended the meeting held on at which your proposal was discussed, are listed below:

Sl. No.	Name of the Member of IHEC	Qualification	Area of Expertise	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
1	Mr R Nandakumar (Chairperson, IHEC)	BA., BL	Legal Expert	Male	No	Yes
2	Dr. S. Bhuvaneshwari (Member-Secretary, IHEC)	MD	Clinical Pharmacology	Female	Yes	Yes
3	Dr S Shanthakumari	MD	Pathology, Ethicist	Female	Yes	Yes
4	Dr Sudha Ramalingam	MD	Epidemiologist, Ethicist Alt. member-Secretary	Female	Yes	Yes
5	Dr D Vijaya	M Sc., Ph D	Basic Medical Sciences (Biochemistry)	Female	Yes	Yes

This Ethics Committee is organized and operates according to Good Clinical Practice and Schedule Y requirements.

Non-adherence to the Standard Operating Procedures (SOP) of the Institutional Human Ethics Committee (IHEC) and national and international ethical guidelines shall result in withdrawal of approval (suspension or termination of the study). SOP will be revised from time to time and revisions are applicable prospectively to ongoing studies approved prior to such revisions.

Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Yours truly,

SECRETARY
PSG IMS&R
COIMBATORE-641004.
INSTITUTIONAL HUMAN ETHICS COMMITTEE

Dr S Bhuvaneshwari
Member - Secretary
Institutional Human Ethics Committee

RADIOGRAPHS

CASE – 1

PRE-OP

IMMD POST OP

1ST MONTH

3RD MONTH

5TH MONTH

CASE – 2

PRE-OP

IMMD POST OP

1ST MONTH

3RD MONTH

5TH MONTH

FAILURE

CASE -1

PRE-OP

POST-OP

1ST MONTH

3RD MONTH

CASE – 2

PRE-OP

IMMD POST-OP

1ST MONTH

3RD MONTH

CASE – 3

PRE-OP

IMMD POST-OP

1ST MONTH

3RD MONTH

MASTER CHART

No	1st month Fracture healing	1st month farcture collapse	1st month implant failure	3rdmonth Fracture healing	3rdmonth farcture collapse	3rdmonth implant failure	5th month Fracture healing	5th month farcture collapse	5th month implant failure
1	-	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
2	-	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
3	+	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
4	-	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
5	-	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
6	+	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
7	+	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
8	-	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
9	+	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
10	-	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
11	-	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
12	-	No collapse	-	+	No collapse	-	+	No collapse	-
13	-	Minimal collapse	-	+	Minimal collapse	-	+	Minimal collapse	-
14	-	No collapse	-	+	No collapse	-	+	No collapse	-
15	+	No collapse	-	+	No collapse	-	+	No collapse	-
16	-	No collapse	-	**+**	No collapse	-	**+**	No collapse	-
17	+	No collapse	-	+	No collapse	-	+	No collapse	-
18	+	No collapse	-	+	No collapse	-	+	No collapse	-
19	+	No collapse	-	+	No collapse	-	+	No collapse	-
20	-	Minimal collapse	**Migration not breaching cortex**	+	Minimal collapse	**Migration not breaching cortex**	+	Minimal collapse	**Migration not breaching cortex**
21	-	Minimal collapse	**Migration breaching cortex**	-	Minimal collapse	**Migration breaching cortex**	-	Minimal collapse	**Revision surgery**
22	-	Minimal collapse	**Migration breaching cortex**	-	Minimal collapse	**Migration breaching cortex**	-	Minimal collapse	**Revision surgery**
23	-	Minimal collapse	**Migration breaching cortex**	-	Minimal collapse	**Migration breaching cortex**	-	Minimal collapse	**Revision surgery**